POWER

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National Efficiency

IN THE mind that observes intelligently the trend of modern thought and current happenings, there must be forming a concept of a nation in which haphazard, self-interested, competing endeavor has been organized into studied, systematic, organized co-operation for the general good.

A certain amount of work has to be done to support the race upon any desired plane. There is plenty of man-power available to do it. In fact, with the present system, or lack of system, there is too much, and unemployment is the problem of the publicist and the nightmare of the toiler.

It takes a determinable quantity of meat and grain and fruit and vegetables to feed a nation, a determinable amount of clothing and shelter to keep the people presentable and comfortable. The load curve ought to be a fairly even one.

Why, then, these seasons of boom and depression, these alternating demands for labor and demands for employment?

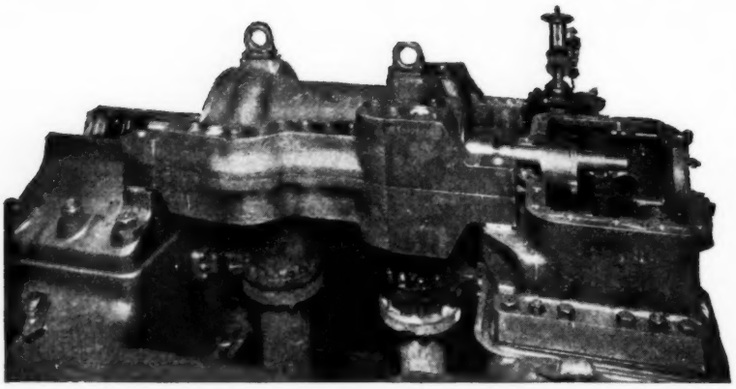
How does the amount of capital invested, the number of mills or factories, the personnel standing ready to serve in any of a number of leading industries compare with what would be required if enough of the most efficient of them were run on a steady load factor all the time?

And who, by and large, pays the difference between such an orderly organization and the present scramble?

The motivating force that controls the intricate interrelations and mutual reactions of our present national housekeeping is profit making. The people collectively have no machinery except as applied to some recognized public services, for regulating the industrial processes upon which their welfare depends.

The activity of the Department of Commerce under Secretary Hoover, in demonstrating the possibilities of the elimination of waste in industry, and the simplification of the processes of production and distribution, through voluntary co-operation of the industries themselves, is a step along a path which, intelligently followed to a logical conclusion, is possible of far-reaching results.

F. R. Low



High-pressure turbine assembled

THIS unit, which is soon to be placed in operation, is the first of such high pressure to be introduced into American power-plant practice. Although *Power* has previously described the Weymouth Station (April 14, 1925) this article gives details of the boiler and turbine and explains the method of operation.

The 1,200-Lb. Boiler and Turbine At Weymouth

TO PRODUCE a pound of steam at 350-lb. gage and 700 deg. F. from water at 32 deg. requires 1,360 B.t.u.

If this could be expanded in a turbine of 100 per cent efficiency to 29 in. vacuum there would be converted into useful work 1,360 — 885 = 475 B.t.u. and the exhaust would contain 885 B.t.u. above 32 deg. as shown in Fig. 1. This would represent a Rankine efficiency of $\frac{475}{1{,}360 - (79 - 32)} = 36.1$ per cent, assuming the condensate to be returned to the system at 79 deg., corresponding to 29 in. vacuum.

It takes only 1,310 B.t.u. to change a pound of water at 32 deg. into steam at 1,200 lb. and 700 deg. If this be expanded in a turbine of 100 per cent efficiency to 350 lb. gage, 118 B.t.u. will be converted into work. And if the exhaust, which is 99 per cent dry, then be reheated to 700 deg. F., through the addition of 168 B.t.u. (77 + 91), the right hand area in Fig. 1, the steam will be in the original condition and capable of converting 475 B.t.u. more through expansion to 29 in. vacuum.

Thus by putting into the cycle 1,310 + 168 = 1,478 B.t.u. per pound of steam, 475 + 118 = 593 B.t.u. will be converted into work and the Rankine efficiency will be $\frac{593}{1{,}478 - 47} = 41.4$ per cent.

In other words, by adding 118 B.t.u. or $\frac{118}{1{,}360}$ = 8.7 per cent more heat, the efficiency is increased from 36.1 to 41.4 per cent, or there is a thermal gain of $\frac{41.4 - 36.1}{36.1} = 14.7$ per cent.

This in a general way is what is being tried out at the new Weymouth station of the Edison Electric Illuminating Company of Boston. Instead of generating all the steam at 350 lb. gage and 700 deg. F., part of it is made in a special boiler at 1,200 lb. and 700 deg., then passed through a high-pressure turbine which exhausts at 350 lb. The exhaust is reheated to the original temperature of 700 deg. and turned into the main 350-lb. system of the station to supply a standard turbine.

The high-pressure equipment, while part of a consistent system, is thus independent and detachable. The arrangement affords a safe and conservative method of trying out the possibilities of pressures double those upon which power-station designers have previously ventured and of solving the problems that its use may disclose without involving the smooth and continuous operation of the main units. If it proves successful, as there is every reason to expect, it will furnish a means of adding considerable capacity and increasing the overall efficiency of a station at a moderate investment.

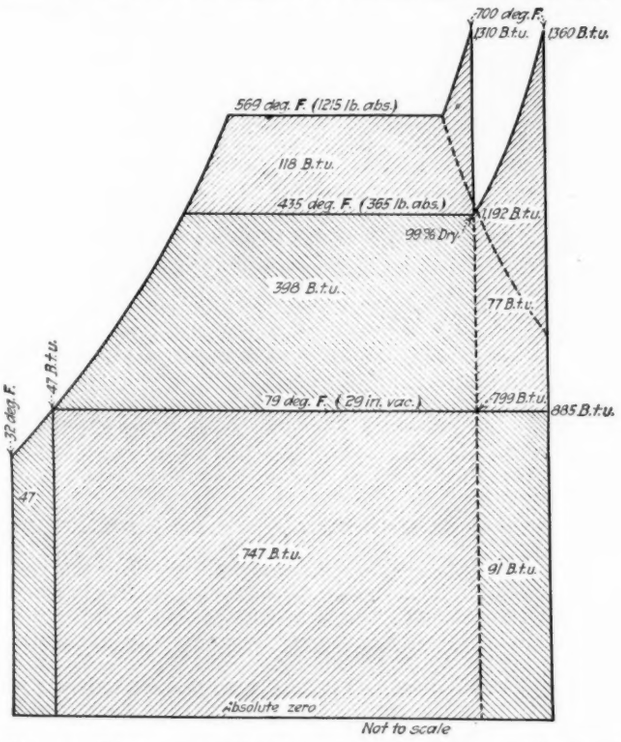


Fig. 1—Diagram indicating gain through employment of 1,200 lb. system

In addition to the 350-lb. boilers installed to run the main 32,000-kw. turbines, the Weymouth station contains one unit designed to furnish steam at 1,200 lb. pressure and 700 deg. F. and to reheat this steam to

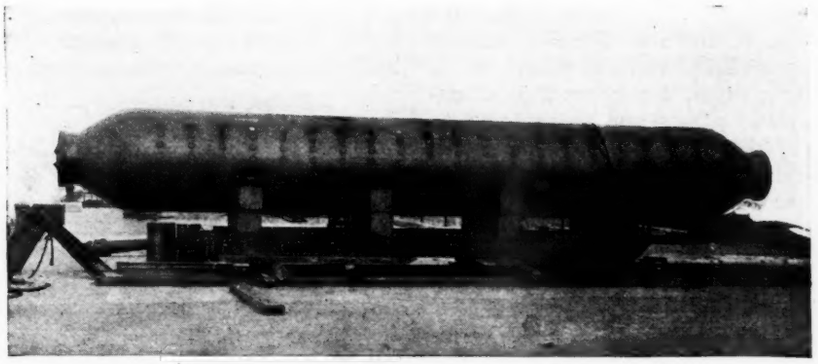


Fig. 2—This drum for the 1,200-lb. boiler is a single forging 32 ft. long, 4 ft. diameter and has walls 4 in. thick. The rough weight of the forging was 81 tons and the finished weight 46 tons

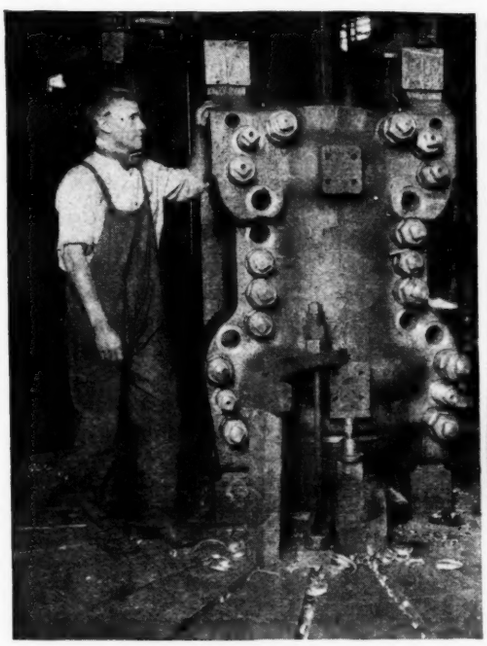


Fig. 3—Machining the turbine casing. Note the massiveness of the flanges

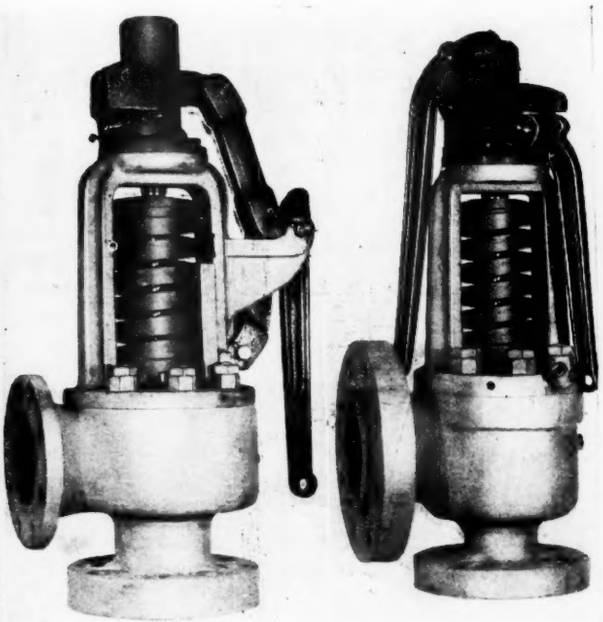


Fig. 4—High-pressure safety valves; "A" for drum and superheater, "B" for economizer

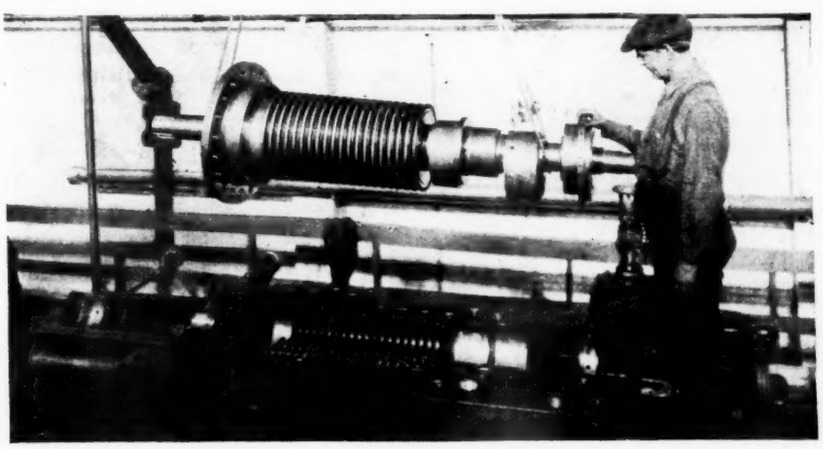


Fig. 5—Rotor of 20-stage 1,200-lb. turbine. The rated capacity is 3,150 kw.

700 deg. when it comes back from the high-pressure turbine. It is a modification of the Babcock & Wilcox inclined-tube, cross-drum type, fitted with a standard Taylor stoker as in Fig. 6, and has a water heating surface of 15,732 sq.ft. with 2,923 sq.ft. of superheating surface. The evaporating tubes, which are 2 in. diameter, are arranged in three passes and separated into upper and lower banks with the primary superheater between. The special reheating element, of 5,938 sq.ft., is located above the upper bank and is arranged at right angles to the tubes in the main heating surface, so that the gases pass over the reheater between the first and second passes. The main boiler baffle between these passes is extended up into the reheater by means of an adjustable damper. When this damper is in its lowest position all the gases are forced past the reheater

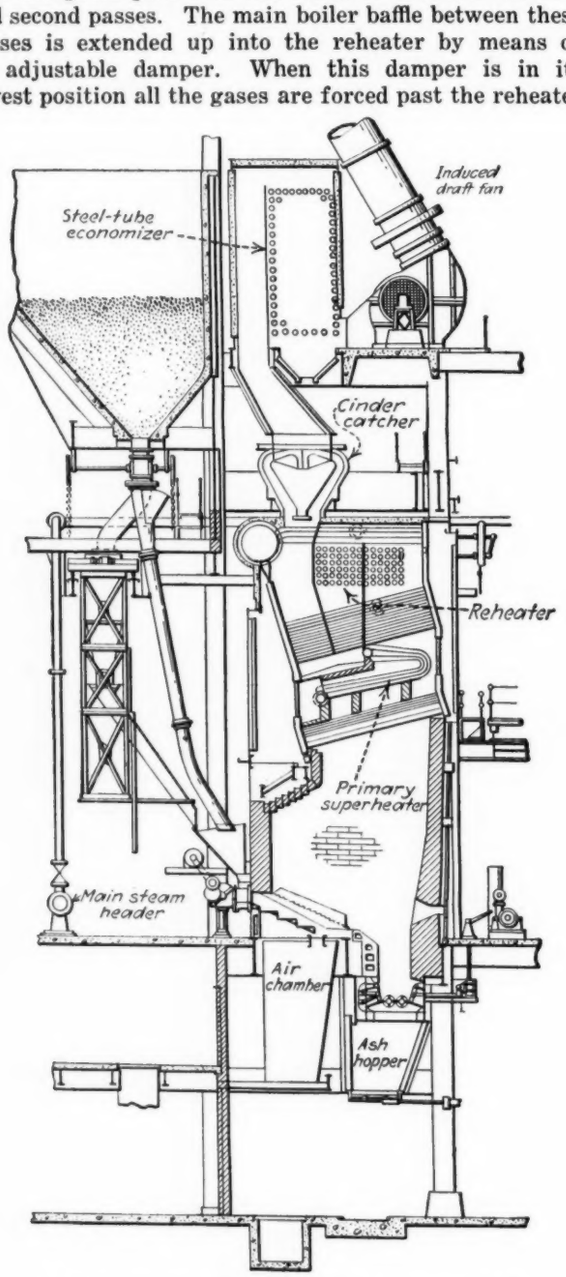


Fig. 6—Section through high-pressure boiler

and when the damper is raised to its highest position the reheater is by-passed and is practically out of service. Intermediate positions give varying degrees of effectiveness to the reheater. The damper is operated by a small motor and is controlled from a panel which carries also a thermometer recording the temperature of the steam coming from the high-pressure turbine exhaust and again after it has been reheated.

One of the principal problems in designing such a boiler was to provide a drum of sufficient capacity to hold the necessary water content at this high pressure

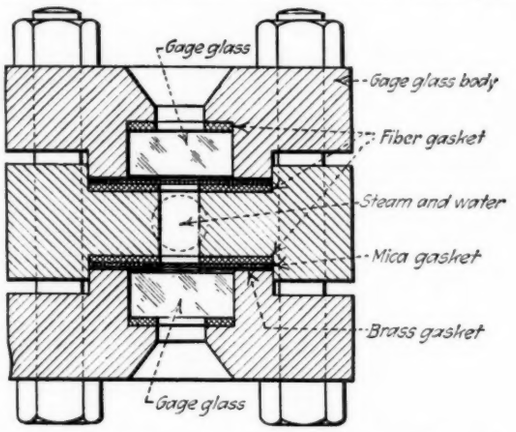


Fig. 7—Plan of special gage glass fitting

The glasses have a thickness of approximately two-thirds of an inch and are inserted in the holders with a clearance of 1/64 in. on the sides and 1/32 in. at the ends. A series of fiber, mica and brass gaskets are used on the inside and fiber on the outside. The pressure exerted by the bolts in clamping the body together is considerable but is not transmitted to the glass.

and furnish the required disengaging surface and steam space. The drum is a seamless steel forging from a solid ingot, forged over a mandrel. It is four feet in diameter and 32 ft. long with walls four inches thick. The finished weight of the drum is 46 tons and it required an ingot weighing 131 tons. Instead of the conventional riveted-in type of head, the ends are drawn down like a bottle (see Figs. 2 and 8) and fitted with elliptical manhole covers, hinged to swing inward and bearing against recesses in the end flanges. Thus the steam pressure holds the covers shut, although yokes are also provided on the outside. The drum is suspended from the building steelwork by a U-shaped hanger at either end, made of 4-in. diameter steel.

Owing to the high pressure involved, a special type of water gage had to be designed. This is shown in section and described in Fig. 7.

The safety valve equipment of this boiler consists of four drum valves and one superheater valve, each with a relieving capacity of 35,000 lb. per hour and a seat diameter of 2 in.; two economizer valves with 1½-in. seats and two small sentinel or warning valves placed on the discharge from the primary superheater and set to blow at 1,170 lb.

It was anticipated that the wear on the safety-valve seats at this high pressure might be so great that reseating would be required after practically every blow and precautions were taken to prevent the valves blowing except at times of rare emergencies. These precautions consisted of the installation of the two small sentinel valves, the warning of which would enable the fireman to check his drafts to prevent the main valves blowing. These valves are mounted on gate valves, making it possible to shut off the one that has blown, for reseating if necessary, and open the gate of the other, without shutting down the boiler.

However, when the valves were tested and set, this excessive wear fortunately did not develop and no more servicing of the safety valves is expected than on the several 500 and 600 lb. plants now in operation. To test

and set these valves with 1,200-lb. pressure required a test boiler carrying this pressure. Only one such boiler of the same type as the Weymouth boiler exists in this country, namely at the Bridgeport, Conn., plant of the Consolidated Safety Valve Co., the maker of these valves.

One of the valves furnished for the drum and superheater is shown at *A*, Fig. 4. This has a fully exposed spring, a toggle joint lifting lever arrangement and heavy construction. The size of these valves is indicated by the fact that although the seats are but 2 in. in diameter the overall height is 35 in. and the weight per valve is 180 lb.

The economizer relief valves shown at *B* are of the same exposed spring type but are smaller, having a 1½-in. seat. This valve is furnished with a lever by which it may be closed manually after blowing down but 2 or 3 lb. It has the regular adjustment for controlling the closing pressure and this lever is used only when it is desired to close the valve with as small a loss in pressure as possible.

The control of the boiler as a whole is by push button from a control and meter board. Push-button control is provided for the forced-and-induced draft fans, together with the individual stoker motors. In addition, the fans are regulated automatically, so as to maintain predetermined draft conditions. Thus from a single point the fireman can, if necessary, control the output and adjust for variations in the quality of coal, clinkering, etc., and maintain the boiler in the best operating condition.

Boiler feed is supplied by an 8-stage single-suction Worthington centrifugal pump which raises the pressure of the main feed system from 425 to 1,300 lb. for the high-pressure service. This pump is driven by a slip-ring motor operating at 3,600 r.p.m. synchronous speed which is automatically controlled so as to maintain the desired excess pressure on the high-pressure boiler. For preliminary operation and as standby equipment, a Weir steam-turbine-driven 4-stage centrifugal boiler feed pump is supplied.

All the high-pressure steam piping is welded throughout, the flanges having Sargol welded joints.

The Twenty-Stage High-Pressure Turbine

The high-pressure turbine is of the straight impulse type, of 9-E design having twenty stages and four bearings. When operating at rating, 3,150 kw. (at 100 per cent power factor), it will pass 133,000 lb. of steam per hour. Thus it will be possible to have three such high-pressure units exhaust to one of the 32,000-kw. normal-pressure units which at full load require 313,600 lb. of steam per hour.

The casing consists of two heavy steel castings forming the top and bottom halves with inlet and exhaust nozzles cast integral with the bottom half. Owing to the great density of steam at 1,200 lb. pressure (a cubic foot weighs between two and three pounds) the steam passages are small. An idea of the massiveness of the casting can be gained by reference to the headpiece and to Fig. 3. The latter shows, however, by comparison with the man, that the overall dimensions of the machine are not great. The nozzles and buckets, as well as the wheels and diaphragms, follow closely the conventional impulse design of small high-speed turbines.

The combination of high steam pressure and high temperature subjects the castings to unusually severe service. Therefore, it is essential that the materials used should maintain their factors of safety over their full working life. Forgings are available of such uniformity that their characteristics may be suited accurately to the required service. On the other hand, steel castings used on high-temperature work have been found subject to flaws that cannot be detected by any of the ordinary methods of inspection. It was decided, therefore, to examine all castings used for 1,200-lb. steam service by X-rays.[2] All valves and fittings and even the casing of the turbine itself were thus examined. The castings submitted were found to be of exceptionally high order but in a few cases subsurface flaws were discovered that would have seriously shortened their life if not made their use dangerous at any

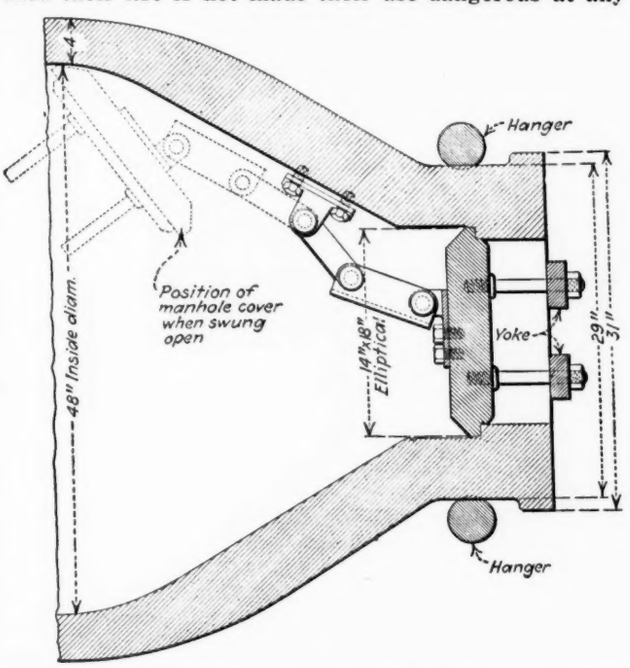


Fig. 8—Plan section of end of high-pressure boiler drum. Note that the manhole cover swings in

time. The use of X-ray examinations has thus been fully justified. It may be noted that this is the first application of X-rays to steam plant inspection and that the high-pressure turbine casing parts are the heaviest castings ever examined in this way.

High Pressure Turbine Controlled by Boiler Pressure

As the high-pressure unit operates in parallel with the normal pressure turbo-generators but at practically constant load, a special arrangement of governor has been adopted. The turbine is warmed up and brought to speed in the usual way. It is synchronized and the generator placed on the bus, the machine being controlled from the main switchboard. As soon as the main breaker has been closed, the synchronizing spring is tightened until the governor has been placed entirely out of action at normal speed, as the unit will then generate power in proportion to the steam flowing through the turbine which in turn is proportional to the pressure at the throttle. The speed of the unit is controlled by the frequency of the main bus as is usual

[2] A detailed report of these X-ray examinations was given in a paper by E. W. Norris and I. E. Moultrop at the Spring meeting of the A.S.M.E., Milwaukee, May 18-21, 1925. An abstract appeared in *Power*, June 30, 1925.

with alternating-current generators in parallel. The steam pressure at the boiler is then adjusted at 1,200 lb. or any desired lower pressure, depending on whether the load to be carried by the unit is equal to or smaller than its full capacity.

In taking the machine off the line the operation is reversed. The tension of the synchronizing spring is reduced until the turbine is under the control of its governor and the generator is floating on the line. The main breakers are then opened and the unit is shut down in the usual way.

Should the load on the unit be suddenly removed or should the turbine overspeed for any other reason, the speed would increase until the governor came into action and controlled the unit. If for any reason the governor should fail to operate the unit would be shut down by the overspeed tripping device.

The high-pressure boiler and turbine operate together as a unit. Should the latter be tripped out under load, the exhaust from the turbine would, of course, be cut off from the reheater. This would subject the reheater to undesirably high temperatures. A special device has, therefore, been developed to by-pass the steam around the turbine so as to maintain the reheater in operation even under emergency conditions. Fig. 9 is a diagram of the piping arrangements. A trip-opening by-pass valve is provided similar to the throttle valve and arranged to be tripped open at the same time that the throttle is tripped closed. This valve is connected to the main steam line on the boiler side of the throttle and discharges steam at line pressure into a special throttling nozzle and expansion chamber which reduces its pressure to 350 lb. At the time that the by-pass valve opens a water valve is tripped, admitting water from the main boiler feed line to a desuperheater mounted at the discharge of the expansion nozzle. The by-pass steam is, therefore, reduced to saturation temperature and is discharged into the turbine exhaust beyond a check valve which prevents its return to the turbine. From this point the steam flows as in normal operation to the reheater where it is brought to its original temperature and discharged to the main steam header. In this way the reheater is protected during emergency and when raising steam or when shutting down the boiler.

The pressure-reducing nozzle is designed to pass the same quantity of steam as the turbine irrespective of the pressure on the line, thus the quantity of steam delivered by the high-pressure boiler to the main steam header of the station will not be affected by the sudden shutting down of the high-pressure turbine.

In starting up the high-pressure equipment, steam is raised in the usual way. The by-pass valve is opened as soon as the pressure reaches the normal line pressure of 350 lb. Steam is then delivered to the main steam header through the by-pass and the reheater, and the boiler pressure is raised to a moderate value.

The turbine is then warmed up by gradually opening the throttle in the usual way, the turbine and by-pass valve operating in parallel at this time. The advantage of using the by-pass is that the increasing load of the high pressure boiler is made more uniform.

After the turbine has been warmed up, it may be brought up to speed and placed under the control of the governor, the throttle valve being opened wide. The generator is then synchronized and placed on the line as described above. As soon as the generator has been placed on the line the by-pass valve is closed and the pressure on the boiler is then raised to give the desired output from the unit which places the plant in normal operation.

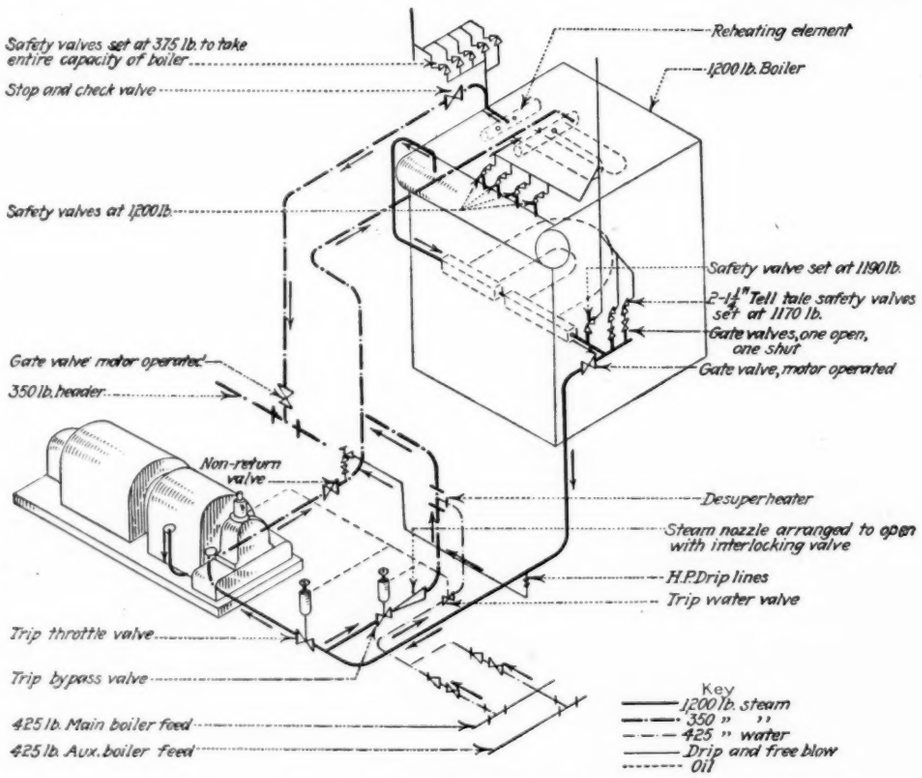

Safety valves set at 375 lb. to take entire capacity of boiler
Stop and check valve
Safety valves at 1200 lb.
Gate valve motor operated
350 lb. header
Non-return valve
Trip throttle valve
Trip bypass valve
425 lb. Main boiler feed
425 lb. Aux. boiler feed
Reheating element
1200 lb. Boiler
Safety valve set at 1190 lb.
2-1¼" Tell tale safety valves set at 1170 lb.
Gate valves, one open, one shut
Gate valve, motor operated
Desuperheater
Steam nozzle arranged to open with interlocking valve
H.P. Drip lines
Trip water valve
Key
1200 lb. steam
350 " "
425 " water
Drip and free blow
Oil

Fig. 9—Diagram of piping systems for the 1,200-lb. boiler and turbine

The process of shutting down the equipment is the reverse of starting up; the boiler pressure is reduced, the by-pass valve opened, and the turbine taken off the line as already described.

The turbine develops power in accordance with the steam flowing through it. Its output is governed, therefore, by the steam pressure, as the flow of steam would be proportional roughly to the pressure. For constant load operation the boiler pressure should be maintained constant at the desired point.

For the data and material in this article *Power* is largely indebted to I. E. Moultrop, Assistant Superintendent, Construction Bureau, Edison Electric Illuminating Co., Boston, and E. W. Norris, Engineer, Mechanical Division, Stone & Webster, Inc., the engineers of the two companies collaborating in the design and construction of Weymouth Station.

Testing Polyphase Watt-Hour Meters With Single-Phase Rotating Standard

By WILLARD F. WALSH
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Two examples are given of testing watt-hour meters connected to two-phase and three-phase circuits with instrument transformers. How to determine the accuracy of the meters and how to make adjustments are explained.

POLYPHASE watt-hour meters are generally tested by one of two methods; rotating standard or indicating wattmeter and stop-watch. Although it is preferable to test the meters from an independent source with an external form of load such as lamps, resistance units or loading transformers, yet it is possible to test them on their connected load by means of a rotating standard.

The rotating standard is connected in series with each of the meter's elements separately, thereby causing the standard's disk to rotate at a proportionate

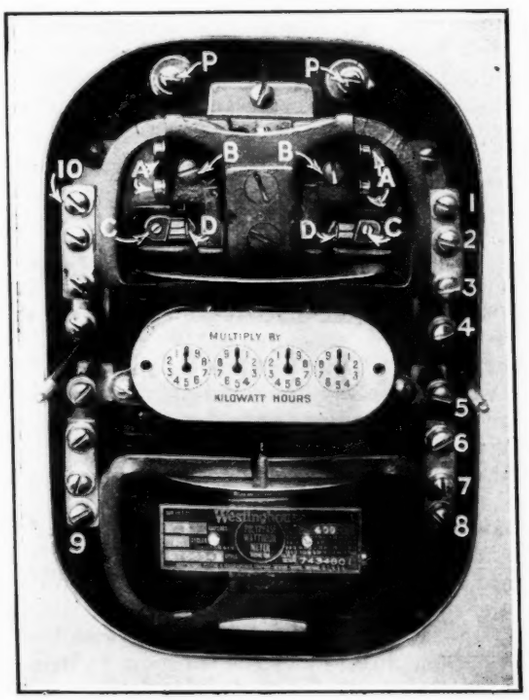

Fig. 1—Type OA watt-hour meter with the cover removed

speed to the meter's disk. Therefore, no matter what variation there may be in the load, the meter and standard are affected equally.

Fig. 1 shows a Westinghouse type OA polyphase watt-hour meter of the switchboard type to be tested, and Fig. 2 shows the connections. The meter being of switchboard type, the connections are made on the back of the board as shown. None of the connections in Fig. 2 is visible from the front of the meter. The polarity marks shown in Fig. 2 indicate the relative instantaneous direction of current through the instrument transformers and assist in connecting the meter

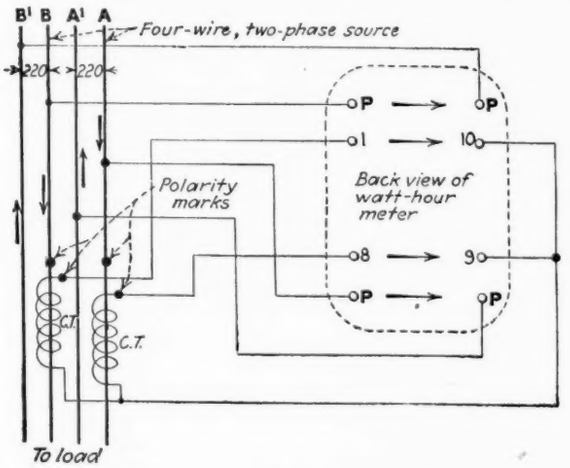

Fig. 2—Diagram of switchboard connections for meter, Fig. 1, on a two-phase circuit

so that it will revolve in the correct direction. A current entering a marked terminal of the transformer's primary is considered as coming out of the same colored secondary terminal. The arrows indicate the relative instantaneous direction in which the current flows through the meter coils for the connections as shown. These arrows should all point in the same direction for correct registration of the meter.

Fig. 3 is a connection diagram for checking the upper element of the meter, Fig. 1, with a Westinghouse type OA single-phase rotating standard. The connections of the current coils to the current transformer and the potential coils to the line are not visible from the front of the meter and are omitted in the figure to simplify the diagram. The meter to be checked is rated at 250 to 5 amperes, 200 volts, 4-wire two phase. The connections on the front of the meter for testing should be made in the following order:

1. Loosen screws 8 and 9 and connect the jumper. This jumper short-circuits the lower current coil.

2. Open strap 7 to 6. The lower current coil of the meter is now disconnected from its current transformer and the latter is short-circuited through the jumper from 8 to 9.

3. The rotating standard, Fig. 3, has a combination potential and current switch *C*, with two pointers, one marked 200 and the other 100. Since the watt-hour meter is for use on a 220-volt circuit, the 200 pointer on the combination potential and current switch of

the rotating standard is placed on the 5-ampere mark, as the meter is connected to a current transformer the secondary of which is rated at 5 amperes.

4. Connect the current leads to the rotating standard and then to posts 1 and 4.

5. Open strap 2 to 3. This connects the current coil of the rotating standard in series with the upper current coil of the meter.

6. Connect the potential leads first to the potential posts of the rotating standard and then to upper potential posts *P* of the watt-hour meter. If the standard rotates backward, reverse the potential leads.

Caution: The current connections must be made in the order as given in 1, 2, 3, 4 and 5 so as not to open-circuit the secondary of the current transformer. An open-circuited secondary of a current transformer will generally cause a permanent change in its accuracy, and a high voltage is built up between the terminals at the point of open-circuit which will endanger the life of anyone coming in contact with the leads or meter. Therefore the current straps should never be opened until the other posts are either connected through a current coil as in the upper element or connected to a jumper lead as in lower element. When disconnecting or changing leads, always first close the connecting straps 2 to 3 and 7 to 6 and then remove and change the leads.

The watt-hour constant of the meter is 66⅔. The constant which is used in testing the meter is equal

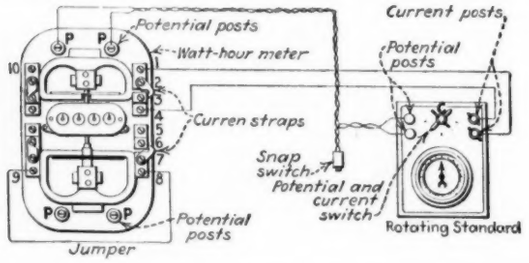

Fig. 3—Diagram of connections for testing upper element in the meter, Fig. 1, with a rotating standard

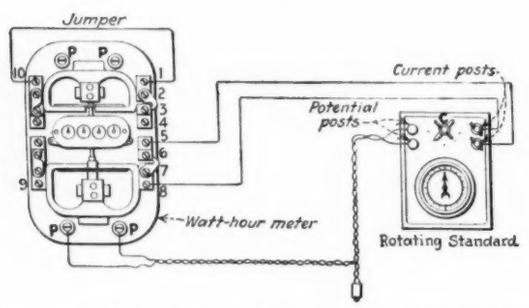

Fig. 4—Diagram of connections for testing lower element in the meter, Fig. 1, with a rotating standard

to the disk constant 66⅔ divided by the ratio of the current transformer, which is $\frac{250}{5} = 50$. Therefore test constant $K = \frac{66\frac{2}{3}}{50} = 1\frac{1}{3}$.

The constant of the 5-ampere 220-volt coil of the type OA standard is ⅔, which is given on a card furnished with the standard.

Start and stop the pointers of the standard by means of the snap switch as the black mark on the watt-hour meter's disk passes an edge of a retarding magnet. The same edge of the magnet and also the same end of the black mark must be used in starting and stopping the disk to avoid error in the result, particularly when taking only a few revolutions. When using an

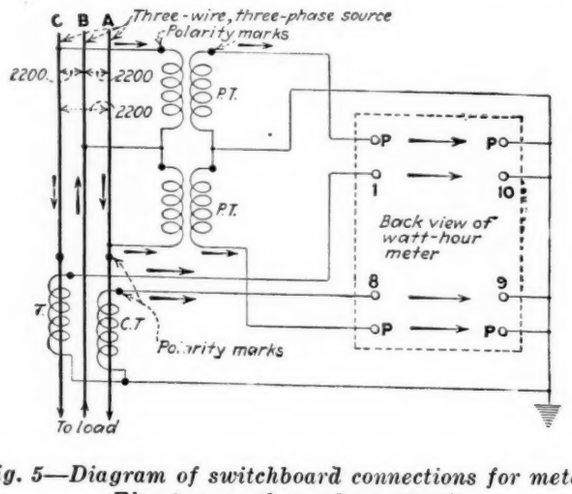

Fig. 5—Diagram of switchboard connections for meter, Fig. 6, on a three-phase circuit

OA standard the pointers can all be brought into zero position with the set-back device. If the standard happens to be of a type without a set-back device, the pointer readings should be taken before and after the required number of revolutions of the meter disk are taken. The accuracy of the meter being tested is determined by the formula,

$$Accuracy = \frac{Watt\text{-}hours\ of\ meter\ under\ test}{Watt\text{-}hours\ of\ rotating\ standard}$$

Watt-hours of meter under test equals the product of the number of revolutions made by the meter's disk times the test constant. Watt-hours of rotating standard equal the product of the number of revolutions made by the large pointer times the standard's constant. At least three successive readings should be taken whenever using the rotating standard, and the average reading applied in the formula. If these three readings do not agree within a few tenths of one per cent, there is probably some form of friction present in the meters or there is a loose adjustment.

As an example, assume that 15 revolutions of the meter are taken and the large pointer of the rotating standard makes 30.09 revolutions. The watt-hours equal the revolutions 15 multiplied by the test constant 1⅓, and the watt-hours of the rotating standard equal the revolutions 30.09 times the constant ⅔; then,

$$Accuracy = \frac{15 \times 1\frac{1}{3}}{30.09 \times \frac{2}{3}} = \frac{20}{20.04} = 0.998,\ or\ 99.8\ per\ cent,$$

if there is no standard correction. If there is a standard correction, the formula is as follows:

$$Accuracy = \frac{Watt\text{-}hours\ of\ meter\ under\ test \times accuracy\ of\ rotating\ standard}{Watt\text{-}hours\ of\ rotating\ standard}$$

Having found the upper element O.K., proceed to disconnect the standard from the upper element and connect it in series with the lower element as shown in Fig. 4 and explained as follows:

7. Disconnect the potential leads from the upper potential posts of the meter.

8. Close straps 2 to 3 and 7 to 6.

9. Disconnect the current leads from posts 1 and 4 and the jumper from posts 8 and 9.

Note that the standard is now completely disconnected and is to be connected in with the lower element.

10. Connect the jumper lead to posts 10 and 1. The upper current coil is thereby short-circuited.

11. Open the strap 2 to 3, thus disconnecting the upper current coil from its transformer.

12. Connect the current leads from the standard to posts 5 and 8.

13. Open the strap 7 to 6. The current coil of the standard is now in series with the lower current coil of the meter.

14. Connect the potential leads to the lower potential posts, *P*, of the meter. Then proceed to check the lower element by taking 15 revolutions of the meter's disk. Suppose the large pointer of the standard makes 30.20 revolutions, then the accuracy of the watt-hour meter is

$$Accuracy = \frac{15 \times 1\frac{1}{3}}{30.20 \times \frac{2}{3}} = \frac{20}{20.11} = 0.995, \text{ or } 99.5 \text{ per cent.}$$

This meter checks quite closely to 100 per cent accurate and therefore does not need to be adjusted. If the inaccuracy had proved to be more than one per cent, it would have been necessary to adjust the magnets. This adjustment is explained more fully subsequently.

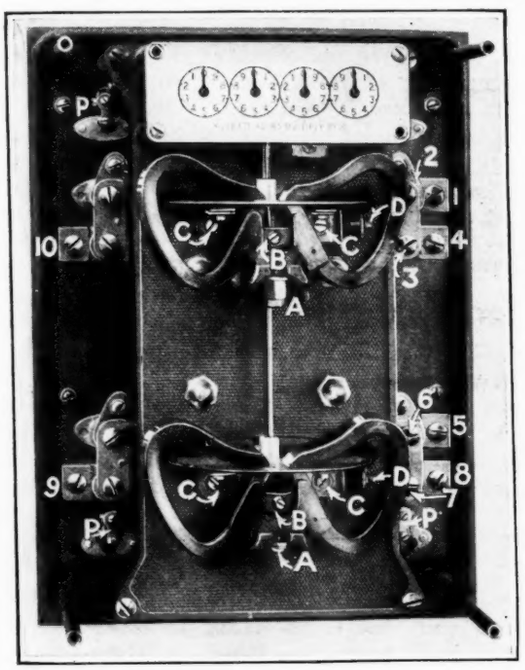

Fig. 6—Type DS-6 watt-hour meter with cover removed

The standard may now be disconnected in a manner similar to that explained in steps 7, 8 and 9.

Fig. 5 is a wiring diagram of a General Electric type DS-6 watt-hour meter on a switchboard connected to potential and current transformers, and Fig. 6 shows the meter with the cover removed. Fig. 7 is a diagram for testing the upper element of the meter, Fig. 6, with a General Electric Type IB-6 single-phase rotating standard. It will be noticed that a similar set of numbers are assigned to the current and potential posts of the DS-6 meter as was put on the type OA, thus allowing the steps from 1 to 14 inclusive to be applied to either type of watt-hour meter. On the type IB-6 standard the current and potential switches are separate so that each is set to the desired values in operations 3 and 6 before the connections are made. The

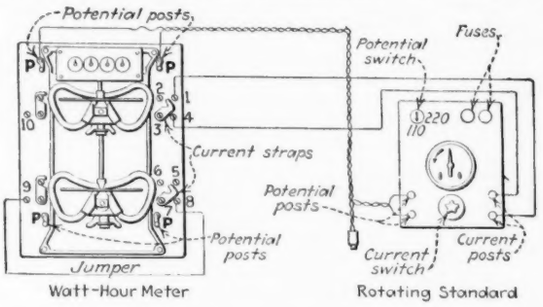

Fig. 7—Diagram of connections for testing upper element in the meter, Fig. 6, with a rotating standard

following example will serve to show the manner in which this watt-hour meter can be tested:

The meter to be tested is for use on a 250- to 5-ampere 2,200- to 110-volt 3-wire three-phase circuit, and its disk constant, which is marked on the disk, is 600. The meter test constant is found by dividing the disk constant by the product of the transformer ratios. In this case the current transformer has a ratio of $250 \div 5 = 50$ and the potential transformer's ratio is $2{,}200 \div 110 = 20$; then use the

$$Meter\ test\ constant = \frac{600}{50 \times 20} = 0.6$$

Since the meter now assumed to be under test is intended for 110-volt service, the standard potential switch is placed in the 110-volt position in step number 6, previously explained. By referring to the test-constant card of the standard, the constant will be found to be 0.3.

Now proceed to check the meter. Suppose that 10 revolutions of the disk are taken and that the standard's pointers read 20.20; then,

$$Accuracy = \frac{10 \times 0.6}{20.20 \times 0.3} = \frac{6}{6.06} = 0.990, \text{ or } 99.0 \text{ per cent.}$$

Therefore, the upper element is one per cent slow. If the lower element is also about one per cent slow, the meter should be adjusted by moving in one of the retarding magnets a little and then rechecking both elements.

Figs. 1 and 6 show the adjustments on a Westinghouse type OA and General Electric type DS-6 meters respectively.

Full load is adjusted on both meters by loosening the retarding magnet's clamping screws *A* and turning the adjusting screws *B*. Moving the magnets in speeds up the meter's disk and moving them out slows the meter's disk down. Changing the position of either magnet on the meter affects both elements alike because the two disks are fastened to the same shaft.

The light-load clamping screws are shown at *C* and the light-load adjusting screws at *D* in both figures. There is an arrow near the light-load adjusting screws which indicates the direction in which they are to be turned. Turning the screw in the direction indicated

by an arrow marked *F*, causes that particular element to speed up and toward *S* causes it to slow down. These light-load adjustments affect only the element that is being adjusted.

When a meter is inaccurate at a load of 10 per cent or less, light load is usually adjusted, whereas on larger values of load the full-load adjustment is changed.

When testing current-transformer meters on connected load, the 1-ampere circuit of the rotating standard should never be used because the current will probably burn out the 1-ampere fuse, if one is in series with the current coil as on some types of rotating standards, and in so doing open-circuit the current-transformer secondary circuit, which would produce harmful results as previously explained. The speed of the slow element, particularly on power factors between 50 to 70 per cent, is likely to be misleading and cause the tester to think that a better check would be obtained on the 1-ampere coil of the rotating standard instead of the 5-ampere. The actual load on the line may be quite high and yet the torque on one of the elements be low and so deceive the tester, causing him to judge the value of secondary amperes as less than what they actually are. Also a sudden change in the load might cause the secondary current to increase above 1 ampere even though it might be less when first connected for test. Information regarding the testing of any particular type of meter can be obtained from the manufacturer. Instruction books are generally furnished with all meters, and much valuable information is contained in them.

The best-known guides in determining whether the mechanical condition of a compressor or an engine is what it should be are pressures, and the indicator offers the best means of plotting a graphical record of the relative magnitude of the successive pressures and volumes inside the cylinder. It is well known that many defects of ammonia compressors can be easily detected without the use of an indicator; on the other hand, it is also a fact that many defects cannot be so readily detected and are brought to light only by its use. Further, experience has proved that a large percentage of the ammonia compressors in operation will show some defective condition; in fact, one will find few that will give a nearly perfect diagram.

Induction and synchronous motors are the most substantially constructed and apparently the least liable to trouble of all the electric motors, but the history of their service shows that they need protection against three conditions: From overload current, which may result from too heavy a mechanical load on the motor, from abnormal frequency, or from abnormal voltage on the power lines; from single-phase power, which may exist when attempting to start the motor or after the motor has started; from phase reversal, which will cause the motor to rotate in an opposite direction to that intended.

When a new refrigerating plant is built or new pipework installed, every piece of pipe and every fitting should be cleaned of scale and dirt. Every length of pipe should be stood on end and hammered to remove the scale. Fittings should be given the same treatment. When new pipework has been tested with air pressure, it should be blown out two or three times to remove loose scale. During the yearly overhauling the same precaution must be observed.

Reducing the Governing Loss to Improve Turbine Economy*

By M. K. Drewry†

UNLIKE most energy transformers, the steam turbine possesses almost constant inherent efficiency throughout its range of load. Only at the higher loads

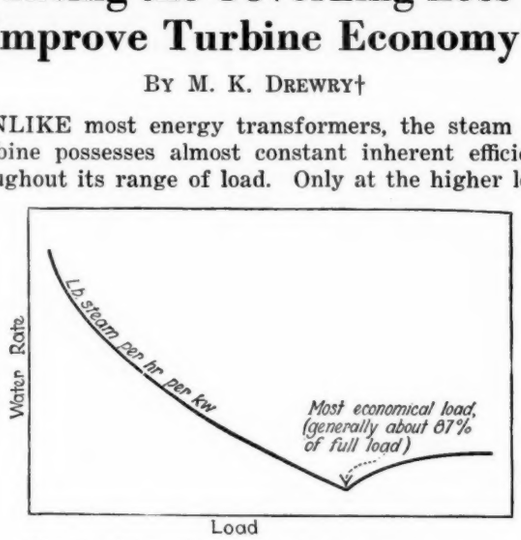

Fig. 1—Throttling at light loads increases turbine water rate

when the shortness of its exhaust blades (though they be of such dimensions that their tips move with nearly the velocity of sound) restricts the free passage of great volumes of steam handled, does the efficiency decrease appreciably. This inherent turbine efficiency times that of the electric generator reaches about 77 per cent in the moderately large, efficient, modern unit, and if alone the determinant of over-all efficiency throughout the range of load, it would show the steam turbine an unusually adaptable machine.

But unfortunately, governing losses in the modern large turbine are responsible for its rapidly increasing water rate at low loads. In order to regulate the amount of steam passing through the turbine at lower loads, much of its original pressure must be wastefully throttled away, thus increasing the water rate indicated by the rapidly rising portion of the curve to the left of Fig. 1 at low loads. In order to have the most economical load of a machine fall at the average load to be carried upon it, and to provide reserve in case of low steam pressure, an overload device is provided, which in admitting by throttling to a lower stage, also quite sharply further emphasizes the thermal loss due to throttling.

Major Turbine Variable Losses Are Throttling Losses

Curvature of the turbine water rate curve is therefore primarily due to throttling away steam pressure in an effort to limit the amount of steam fed the turbine. Only at the most economical load shown in Fig. 1, does the initial stage pressure nearly equal that of the boiler pressure, the difference being pipe and valve friction loss, plus a slight designed throttling through the governing valve to maintain good regulation.

Turbine practice states that this pressure margin for governing must be about 15 lb. in the case of

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*Extract from a paper, "Steam Turbine Technics," which won a prize in a contest conducted by the Technical League, an organization of those connected with the company to which the author is attached.

†Technical engineer of power plants, the Milwaukee Electric Railway & Light Co.

normal steam pressures (250 lb.), though the friction loss in the valve may be only half that amount. Where some units in a power station may be operated continuously at their most economical point, release of the overload valve from functioning and adjustment of the governor to reclaim the 7-lb. pressure drop otherwise needed for regulation, nets an appreciable economy. Eliminating the throttling of steam to a lower pressure is equivalent to raising boiler pressure an equivalent amount.

Throttling Loss Diminution a Duty of Operator

Decreasing the total throttling losses of a power station is the purpose of correctly adjusting the load carried by each turbine. To have one machine operate

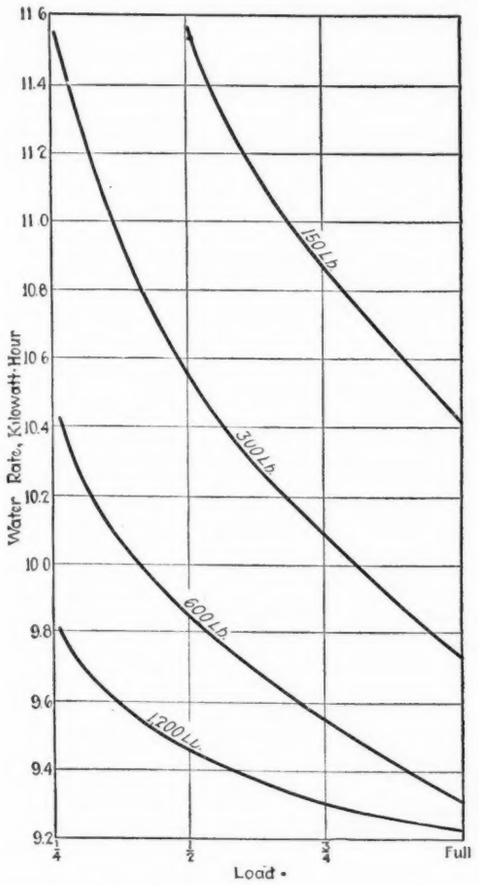


Fig. 2—Low loading of high-pressure turbines makes less relative loss than for low-pressure turbines

below its most economical load and the other above that point is to lose heavily and rapidly in economy. Water rates of the turbines at the Lakeside station change 1 per cent in only 4 per cent kw. variation in load, which figure would indicate a pure loss if one unit was 4 per cent above its most economical load and the other that amount below. With regard to the efficient operation of turbines the most important duty of an operator is to so adjust the loads on his turbines that throttling losses are a minimum.

Improper adjustment of the governing mechanism of the turbines, indicated by an excess above 15 lb. pressure drop through the regulating valve at the most economical load, is often the cause of continuous losses. Likewise, the improper sizings of nozzle areas, causing the most economical load point to be a larger load than the average load, may be responsible for excessive throttling losses. An efficient operator watches these details in the interest of limiting throttling losses.

Throttling Loss Decreased by Correct Station Loading

Just as the throttling losses of a station should be made a minimum by proper balancing of load upon individual turbines, so should the throttling losses of a system of stations be made as low as possible by adjustment of proper load on such station. Though one station may be inherently of much lower efficiency that another, it may merit the apportionment of considerable load for the sole purpose of allowing the larger most efficient station to operate at its most economical point. If by transferring a small portion of its load to another station, a large station can generate all of its remaining output more economically, then hardly any degree of inefficiency in the small plant carrying the relatively small load can offset the gains made in the larger on the large load portion.

High Boiler Pressures Mean Less Throttling Losses

The advent of higher pressures in power stations has a noteworthy effect upon throttling losses. The curves in Fig. 2 show that the low-load water rates of high pressure turbines are relatively better than those of low pressure machines, which is an important consideration in choosing station pressures.

Thus, a 1,200-lb. unit has a comparatively "flat" water-rate curve, while a 150-lb. unit has a sharply rising curve.

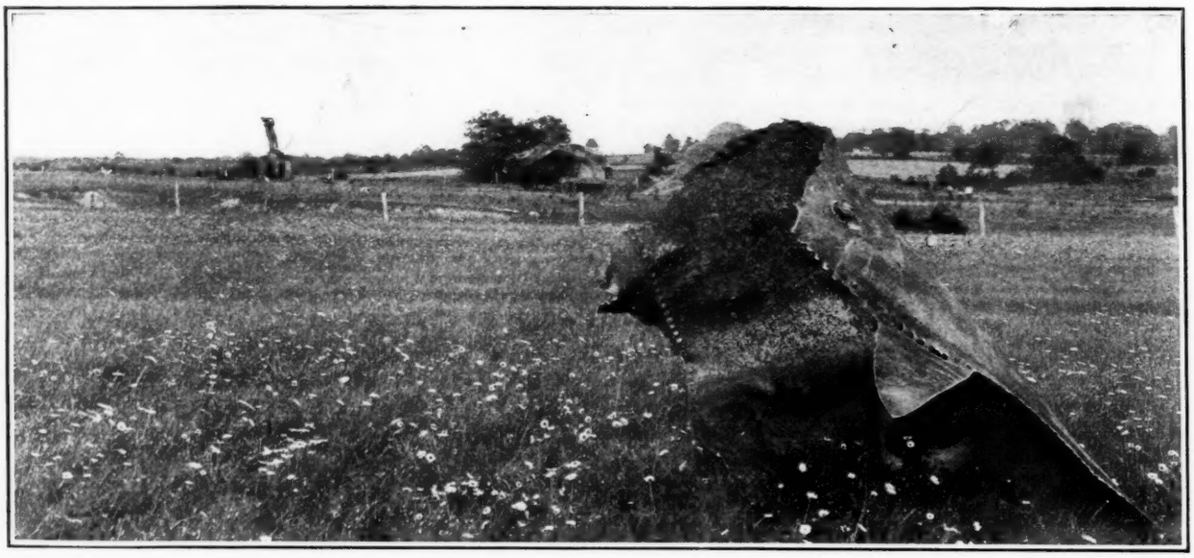
No Sludge Without Water

According to the recently issued serial report on lubrication by the Prime Movers Committee of the N.E.L.A., the presence of water is a necessary condition for the sludging of turbine lubricating oils.

The Lubrication Subcommittee made a series of laboratory tests for comparison with results obtained in actual operation, the aim being to obtain data that could later be used for the formulation of specifications when laboratory tests that are sufficiently reproducible have been obtained.

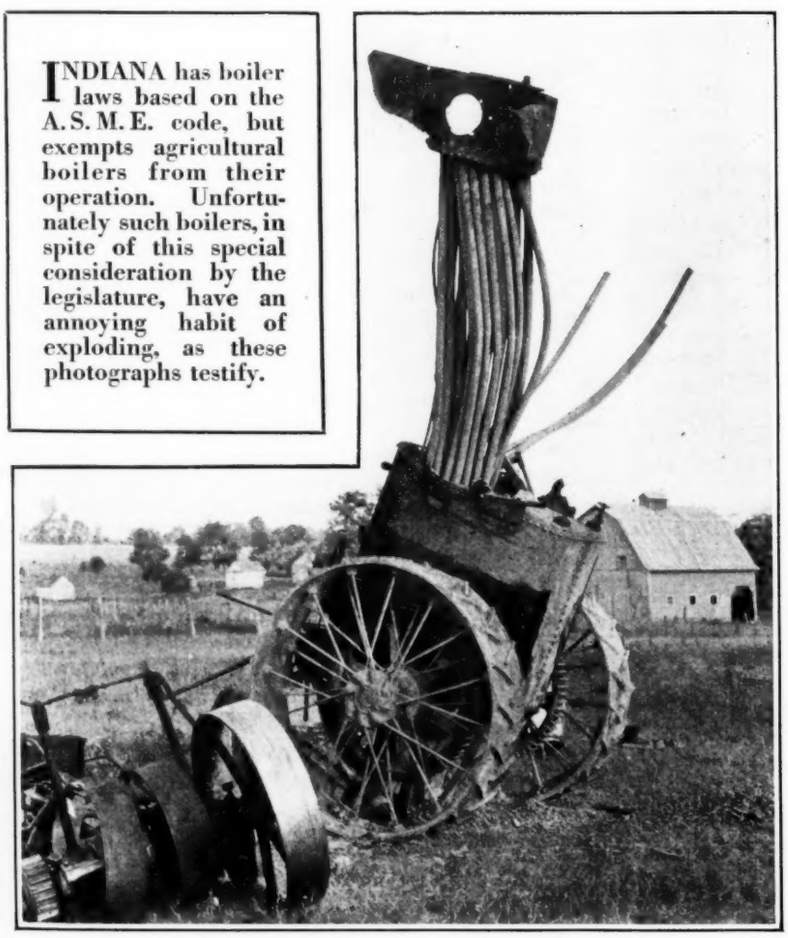
Theoretical considerations for some time past have indicated that the breaking down of the lubricating medium is essentially due to oxidation which, of course, is promoted by the presence of heat or catalytic agents. It was part of this theory that no sludge or emulsion would appear unless moisture was present in the lubricant. This latter has been questioned by some who have noticed the appearance of sludge and emulsion where apparently there was no water. In the committee's opinion water has been taken up in such cases in small quantities for the production of sludge as fast as it arrives; hence there was no free water to see. The three methods of testing used were the Herschel demulsibility test, the modified resistance-to-emulsion test (R.E.) and the Sligh oxidation test.

The results of these tests were compared with the "durability" of the oil determined in a so-called "sludge accelerator." So far the committee has been unable to find any test that would invariably check up with that obtained by the sludge accelerator, but it feels that progress is being made in this direction.



Indiana Tractor Boiler Explodes

INDIANA has boiler laws based on the A. S. M. E. code, but exempts agricultural boilers from their operation. Unfortunately such boilers, in spite of this special consideration by the legislature, have an annoying habit of exploding, as these photographs testify.



What Happened

The steam tractor, whose remains are here pictured, was threshing wheat this summer near Bedford, Indiana. According to witnesses the explosion occurred when an attempt was made to pump water into the boiler after the water level had disappeared from the gage glass. Whatever the cause, there was a loud report and the air was filled with large and small parts of the boiler and engine. The boiler shell was torn open and hurled more than three hundred feet. Although almost a dozen men were in the vicinity, no one was killed, but several were seriously injured.

Checking the Performance of Surface Condensers and Cleaning for Maximum Efficiency

BY CHARLES E. COLBORN*

THE operating methods outlined in a previous article by the author[1] insure high efficiency for the capital invested in condenser cleaning. A systematic checking of performance is here taken up, together with some data on the results obtained from the cleaning of condensers by various means.

TO STUDY the day by day performance of surface condensers, as described in a previous article by the author,[1] it is necessary that all comparisons should be made at a constant load as well as constant volume of circulating water. This practically eliminates two variables of performance, load and cooling water, from consideration.

Having secured the requisite conditions, there are certain readings of temperature and pressure that should be taken. These are shown on the chart, which is a specimen of that used in reporting daily condenser operation in a large power station.

The observed conditions of water temperature, steam flow and steam temperature are utilized in calculating the condenser performance by the use of standard formulas. The most important thing to know is the fifth item, "Difference from the guaranteed vacuum."

The guaranteed vacuum is readily obtainable from the maker of the condensers, whose curves will cover such load ranges as may be desired or may include the entire load range of the turbine-and-condenser unit. By subtracting the vacuum referred to a 30-in. barometer as read at the condenser entrance, the "difference" may be obtained from the vacuum as guaranteed. This, if plotted daily, will result in a curve showing the trend of operation of the condenser and hence the relative condition of the unit.

Having obtained this figure, the other variables should be calculated to determine when possible, to what cause this observed difference is due, which may be a restriction of the flow of circulating water.

Pump trouble may be indicated by the amount of circulating water passing through the condenser, which may be approximated by use of the formula,

$$g.p.m. = \frac{S \times 1.888}{TR.} \qquad (1)$$

in which *g. p. m.* is the gallons of circulating water per minute, *S* the steam exhausted to the condenser per hour, in pounds, and *TR* the rise in temperature of the circulating water in its passage through the unit.

The calculated amount will vary somewhat from day to day owing to inaccuracies in the temperature readings, but a continued change of any magnitude in the results will invariably point to some trouble in the pump system. This can be located by inspection of the pumps and removed.

From a study of the variation of the coefficient of heat transfer and amounts of circulating water, decisions can be made as to whether the amount of the continued falling off in vacuum is due to tube fouling or an increased amount of air leakage. This latter affects the coefficient of heat transfer, causing it to decrease. However, it is possible in practically every case to check the air leakage daily. Moreover, an amount sufficient to affect seriously the heat transfer will also have a marked effect on the vacuum and thus signal itself to the operators.

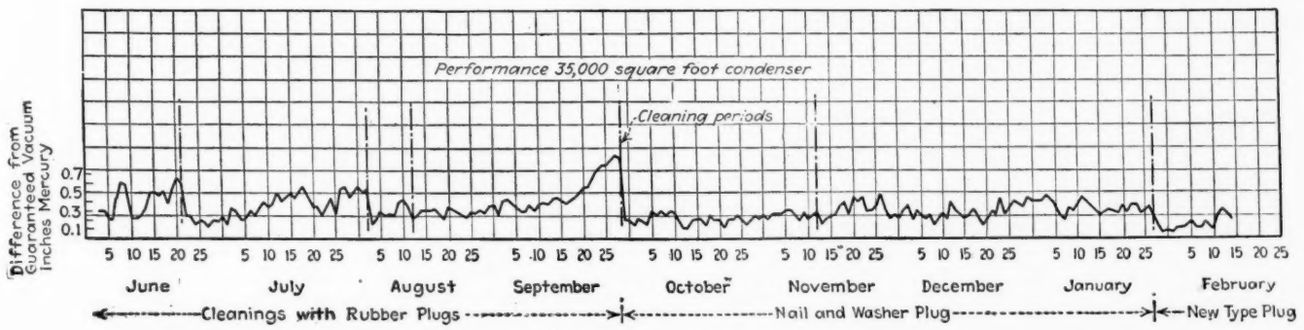


Fig. 1—Effect of cleaning 35,000-sq.ft. condenser with different types of plugs shown by closeness of vacuum to that guaranteed

The coefficient of heat transfer in the condenser is calculated by the following formula:

$$U = \frac{S \times 940}{A \times MTD.} \qquad (2)$$

In this, *U* is the coefficient of heat transfer in B.t.u. per hour transferred from steam to water per square foot of tube surface per degree temperature difference between the steam and water; *MTD* is the arithmetical mean temperature difference between the steam and

*154 Locust Avenue, Fairmont, W. Va.

[1] *Power*, Nov. 1923: "Determining the Economical Interval Between Cleanings of Condenser Tubes."

water in the condenser system, and *A* is the tube area in square feet. The constant 940 represents the B.t.u. removed per pound of steam condensed and will be found sufficiently accurate for the purposes of the calculation.

The arithmetical mean temperature difference is, as its name implies, the difference between the exhaust-steam temperature and the mean circulating-water temperature, or

$$MTD = T.\ exhaust - \frac{T.\ outlet + T.\ inlet}{2} \qquad (3)$$

The arithmetic mean is used in this case, rather than the logarithmic *MTD*, because the accuracies of the other readings do not justify the finer calculation obtained by means of the logarithmic function.

In Fig. 1 is shown the record of the performance of a 35,000-sq.ft. condenser covering a considerable period.

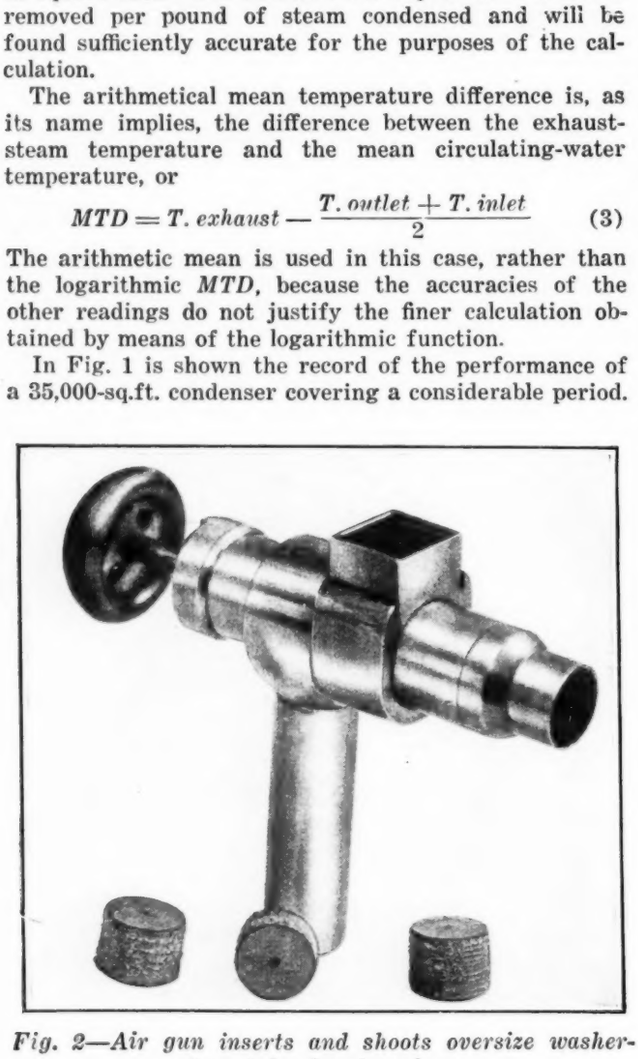


Fig. 2—Air gun inserts and shoots oversize washer-type tube-cleaning plugs

The tests were made daily upon the condenser as outlined previously, and the need for cleaning forecasted from the curves. The results of cleaning are made clear by the curves for each period.

In this condenser the circulating water contains a large amount of iron hydroxide and gelatinous compounds resulting from mine drainage in suspension. These, together with the natural silt of the river, tend to cause a rapid deposit of sludgy slime on the tubes. In removing this slime, it was the practice for a number of years to use the old-fashioned nail-and-leather-washer cleaner, shot through the tube with a compressed-air gun. This always gave good results but was hard to use and took a large amount of time to clean a condenser with.

When rubber plugs were introduced, their use was at once begun, but with varying results. In the course of a year or so it was noticed that very often the vacuum on the condenser would be higher after a couple of days of service than when the condenser was first cleaned. Later it came to the point where this type of plug would scarcely cause any gain in vacuum, even though applied frequently.

At this time an investigation became imperative. Many tests and considerable reasoning developed the theory that apparently the rubber plug became smaller in use, and thus formed a thin, tightly packed mud scale against the tube surface. This scale, becoming mossy and water soaked after a couple of days' service, was then more heat conductive, thus accounting for the increased vacuums. New plugs were secured and the tests repeated, but it was found that these plugs actually did become several thousandths of an inch less in diameter after service amounting to shooting one condenser, which substantiated the theory. Those that still remained large and consequently hard to insert in the tubes were discarded quickly for that reason by the men doing the work. The result was that after three or four condenser cleanings all those plugs that had not become smaller had been discarded and their usefulness ceased.

The new plugs were expanded by driving nails into them until they were about five thousandths of an inch larger than the tubes, and again put through the tests, but again were found to have become smaller than the tube inside diameter through use. It would seem that this plug, instead of expanding actually stretched in the passage through the tube. Plugs were secured of another and more lively rubber composition, but showed the same characteristics.

CHART FOR CONDENSER PERFORMANCE REPORT

DAILY CONDENSER REPORT — Efficiency Department

POWER STATION — Date.....192..

Barometer				(Mercury)
Condenser No.	1	2	3	
Load, thous. kw.				
Thous lb. steam per hr				
Abs. press., in. hg.				
Difference from standard abs. press.				
Exhaust temp., deg. F.				
Hotwell temp. deg. F.				
Inlet circ. water temp., deg. F.				
Outlet circ. water temp., deg. F.				
Circ. water temp. rise, deg. F.				
Circ. pumps in service				
G.p.m. circ. water				
Coeff. heat transfer arith.				
Service hr. since cleaning				
Air leakage, cu.ft. per min.				

Work Recommended	Date recommended	Date completed

Remarks:

Data by _____ _____ Efficiency Engineer

Copies:—
Supts.
Efficiency Dept.
Chief Engr.

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It became evident that something other than the type in use would have to be developed for that station if any success was to be had with cleaning condensers by the plug-shooting method. The first experiment was made with the familiar leather and nail type using rubber belting washers instead of leather. These were first tried about Sept. 27. The curve, Fig. 1, shows the large gain which apparently resulted from their use, as compared with that from the previous types. In order to gain an idea of their efficiency six tubes were shot with the old-type rubber plugs which had been expanded so as to be larger than the tube bore. Then these six tubes were shot with this washer type while the plugs and ejected material were caught in a bucket.

It was found that they had removed almost one ounce of mud per tube which the old type had not touched.

This pointed out what characteristics were necessary for such a plug, and after further experimentation and research a commercially practicable plug was developed. This superseded the nail-and-washer type in January, with the results shown on the curve. Since that time this improved type of plug has been tried and adopted by several larger stations for such work.

The plugs are used about four-thousandths of an inch in diameter oversize. They may be inserted in the tube and shot through by hand, using the older types of compressed-air guns. It was the custom as followed in many plants to shoot the entire condenser from the front end. With the use of the new type considerable trouble with stuck plugs became evident, and it was determined through investigation that the plugs must be shot through the tubes in the direction of water flow for best results.

The mud and scale that deposited in the tubes seemed to reach a maximum in a 20-ft. tube about 6 ft. from the exit end. By shooting the top half of the condenser from the front, or against the direction of water flow, it was necessary for the plug to push this large amount of mud nearly all the way through the tube. After putting the plugs through in the reverse direction (parallel to the water flow), however, a considerable improvement in the ease of shooting was noticed.

Air Gun Shoots Tube-Cleaning Plugs

To facilitate the use of the oversize plug, a special gun was developed, as in Fig. 2. It has proved convenient for this work as it is then unnecessary to introduce the plugs into the tubes by hand since they are dropped into the gun, which automatically inserts and shoots them through the tubes.

The application of this plug is now bringing condensers that are over five years old within one-tenth inch of the guaranteed vacuums, and is removing not only the mud deposited between ordinary cleaning intervals, but also a large amount of the old scales left from the other cleaning methods. Through the use of the special gun, Fig. 2, two or more plugs may be shot through each tube as readily and quickly as one was previously. This insures a double cleaning action. The results as shown on the curve, Fig. 1, are self-explanatory.

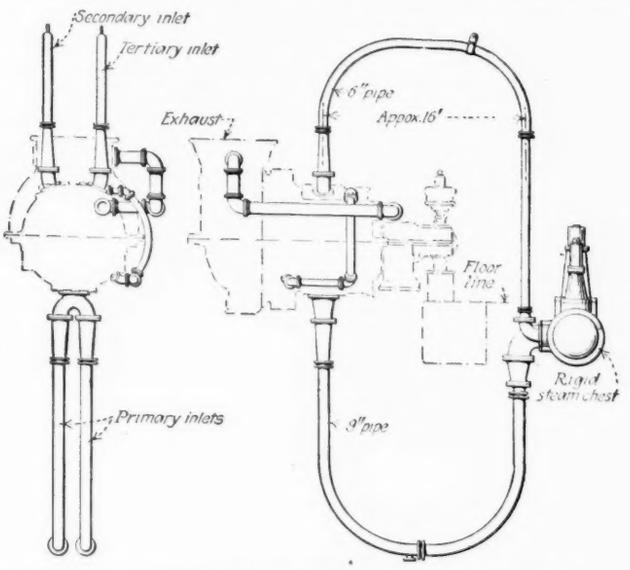
Anchored Steam Chest Flexibly Piped to Turbine

A rigidly mounted steam chest containing the governing valves may be flexibly connected by a number of steam pipes to the high-pressure element of a large compound turbine as shown in the figure. Steam for the primary inlet is here conducted by two bent pipes below the floor, while that for the secondary and tertiary inlets, which require steam successively as the load increases above that which the primary will supply, travels through pipes arched above.

Steam connections of this general type were specified for all three cross-compound units at the Crawford Avenue Station of the Commonwealth Edison Company, Chicago, although these units were made by three separate concerns, the Westinghouse Electric & Manufacturing Co. and General Electric Co. as well as the C. A. Parsons Co., of England. Several pipes of comparatively small diameter are thus attached to each turbine cylinder, the latter shown in dotted lines, giving greater flexibility than one large pipe, which would be ordinarily required were the steam chest attached to the cylinder.

On account of the fact that the turbine as here shown would tend to expand toward the steam chest and the piping toward the turbine, these bends are adjusted so as to be slightly shorter than the space to be spanned when all is cold. This amount, which must compensate for expansion, is therefore calculated and the piping shortened accordingly, so that it must be sprung into place when connected cold.

Since the steam chest is anchored, strains due to movements of the main header are prevented from being communicated to the turbine steam connections and hence to the cylinder. On many large units, however, it is desired to take advantage of the flexibility inherent in the header itself, so that the steam connection is then run direct, without such an intermediate fixed point.



Four steam pipes flexibly connect turbine (dotted lines) to externally anchored steam chest

Greater unit sizes entail increased dimensions, although blade clearances remain the same, so that there is a greater sensitiveness to pipe strains as capacities increase. Elevated temperatures and pressures aggravate conditions as pipes tend to become stiffer and expansive movement greater.

If only one wire of an alternating-current circuit is in an iron conduit, the alternating magnetic field set up about this conductor will induce a voltage in the conduit, which, if two points on the conduit are connected together to complete a circuit, will cause a current to flow. This current may be sufficient to heat the conduit seriously and may even cause a fire hazard. On account of the conductor being surrounded by iron, the magnetic field set up by the current will be many times that if the conductor were in open air. This increase in the magnetic field will increase the induced voltage in the conductor, causing not only a greater voltage drop in the line, but also a lower power factor than if it were not surrounded by iron.

Industrial Power-Plant Records Versus Costs

By H. H. FORCE
Plant Engineer, Continental Motors Corp., Muskegon Plant

IT IS not unusual to see in print records and costs of public service power plants, but seldom is anything published on industrial plants. Here is the record and cost system of a 9,000-kw. industrial plant which, with others similar, are of interest and value to plant engineers. This plant has been in service 4½ years.

There are six vertical boilers totalling 48,000 sq.ft. of heating surface. The boilers are equipped with soot blowers, feed-water regulators, damper regulators, steam-flow, air-flow, stack-temperature meters, and three-pen recording draft gages. Underfeed stokers with hand-controlled individual electric drive are used, but no economizers or air preheaters. Air blocks are installed in the front and side furnace walls and in the bridge wall. Forced-draft fans are steam-turbine driven, and their speed is controlled by the steam pressure.

Each boiler has a coal scale. Feed water is heated and metered in open-type feed-water heaters. Coal is received by rail, dumped in a track hopper and crushed and elevated to a 1,200-ton bunker. Outside stock is handled by a locomotive crane. Ashes are dumped directly into standard gage cars and unloaded by locomotive crane mostly to a fill near the plant. Some ashes are sold at nominal charge to the city and employees.

Readings Taken Every Two Hours

Readings are taken every two hours of the total water evaporated, the steam generated and the coal burned for each boiler, and the evaporation calculated. About a gallon pail of coal is taken from each boiler coal scale at each reading; ash samples are selected from each boiler every time the ash hoppers are dumped. The coal and ash samples are scientifically prepared and analyzed daily and the efficiency and ashpit loss determined.

The CO_2 is taken with Orsat once daily and estimated from air-flow readings for a 24-hour period and used to get stack losses. All auxiliary steam is metered, as well as that induced for heating feed water. Steam pressure and temperature, feed-water temperature in and out of heaters, and low-pressure steam are recorded on graphic charts.

The turbine room has three 2,500-kw. turbines arranged to run on high-pressure steam at 175 lb. and 100 deg. F. superheat and to extract steam against 6 lb. and to induce steam at from 2 to 6 lb. One 1,500-kw. turbine is arranged to run on high-pressure steam and extract steam against 6 lb. pressure. All turbines have jet condensers with electric motor drive, separate exciters both steam and electric driven.

There are kilowatt-hour meters on each turbine and each feeder including power-house auxiliary. Hourly readings are taken on indicated kilowatts, amperes on generators and exciter, also outside temperature, barometer, condensing-water temperature in and out and low-pressure steam temperature at condenser, also line and inlet steam pressure at turbine, exhaust-steam pressure and bearing and governor oil pressure.

The foregoing information with charts from graphic meters is turned into the chief engineer's office early in the morning and by noon data have been compiled, coal and ash samples analyzed and results of the previous day's run plotted on a continuous curve sheet hanging in the chief engineer's office. A section of curves is shown herewith. Curves such as these plotted from 24 readings are likely to show wide variations due to reading meters with large constants.

TABLE I—DISTRIBUTION OF STEAM DELIVERED AS NET EQUIVALENT HIGH PRESSURE IN PERCENTAGE OF TOTAL

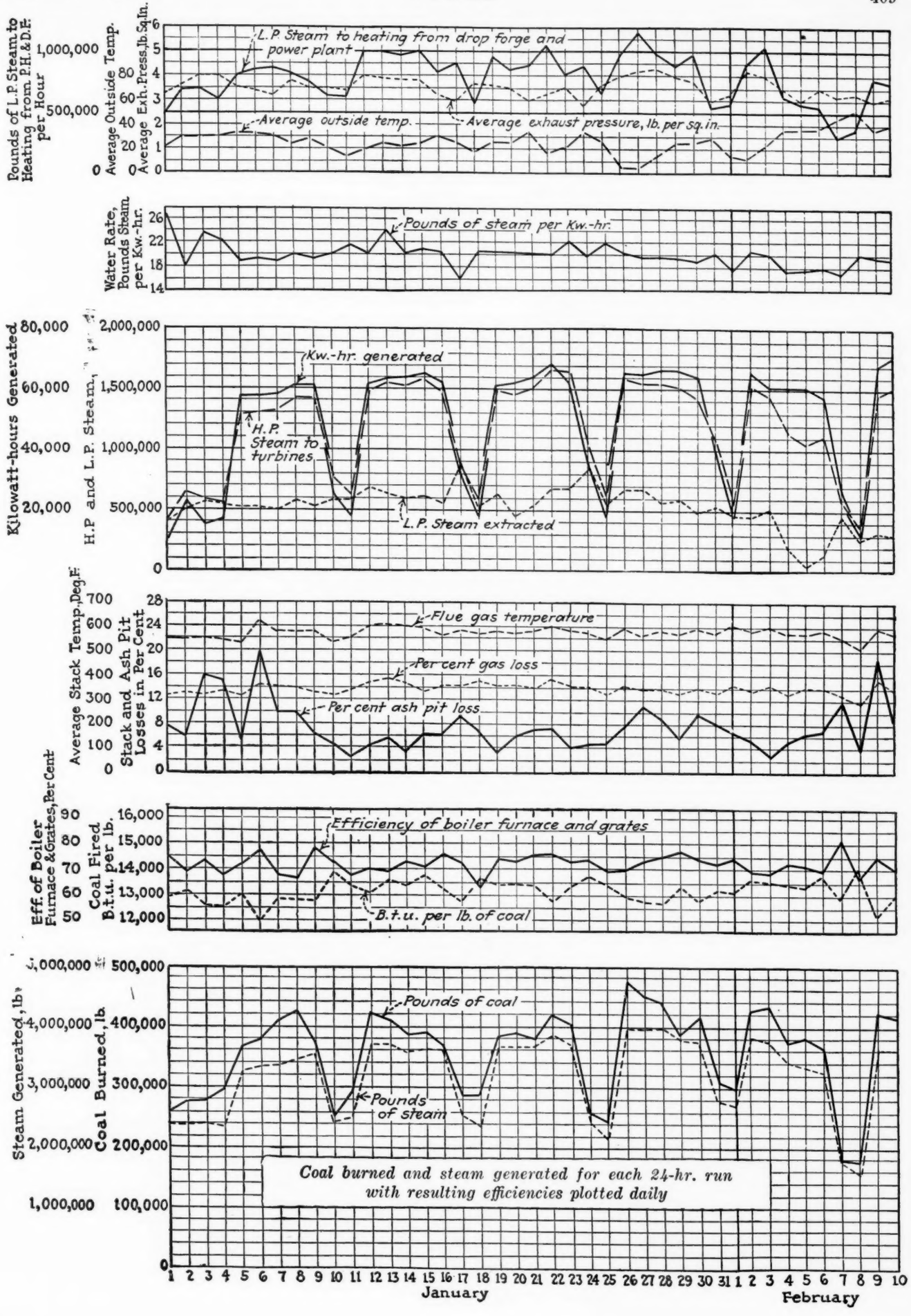
	Jan.	Feb.	March	Year	
	1925	1925	1925	1924	1923
Turbines	25.35	30.75	36.91	35.50	41.20
Drop forge	6.45	8.69	11.62	10.90	17.60
Process	30.25	30.11	27.31	22.20	13.50
Foundry	13.25	9.99	7.62	6.70	6.30
Heating	24.70	20.46	16.54	24.70	21.40
Total	100.00	100.00	100.00	100.00	100.00

Week-end efficiencies are low owing to banking losses and starting of cold boilers. At some periods shown on these curves this plant was receiving a widely varying quality of coal; at one time coal was received from as many as five different sources and each source shipped from more than one mine and some from as many as four in one week's time. Coal was noted to change radically as many as three times in ten hours' operation. This materially affects curves such as these. The grade and quality of coal used is decided by the location of plant and equipment, but a fairly uniform quality is imperative to the best operation in any stoker-fired plant.

Plant Divided Into Two Parts for Cost Computing

For cost purposes this plant is divided into two separate departments, a steam-generating department (boiler room) and an electricity generating plant (turbine room). All materials, labor, supplies, equipment, grounds, buildings, taxes, overhead, fixed charges, etc., are divided between the two and separated for each under divisions recommended by the Public Service Commission for public service plants.

All high-pressure steam is metered twice, first as generated by boiler and second as delivered to user. From the first of these is deducted in equivalent high pressure the steam used by the boiler auxiliary and heaters and the heat returned in water from the heating system and the remainder, the net equivalent high pressure, is the quantity on which cost is based. It runs about 85 per cent of water evaporated. The net equivalent high-pressure steam is determined for each user and percentages of total delivered, determined as shown in Table I. Net equivalent high-pressure steam for turbines is the reading of the high-pressure



Coal burned and steam generated for each 24-hr. run with resulting efficiencies plotted daily

meter plus approximately $\frac{1}{16}$ of the low pressure induced, minus 92/100 of steam extracted for our steam conditions. The ratio $\frac{1}{16}$ is calculated theoretically and checked experimentally for these units by the turbine manufacturers. The net equivalent steam for the drop forge is the reading of the high-pressure meter minus 92/100 of the steam to the heating and $\frac{1}{16}$ of the steam to the turbines, for process the reading of high-pressure meters, for foundry the reading of the high-pressure meter minus the heat in returned water; for heating 92/100 of the reading of the low-pressure meters minus that returned to the feed water, assuming a pound of water returned for every pound of steam delivered.

Distribution of Costs

The total cost of the boiler room is divided among these users in percentages as determined above; thus they absorb all losses and shrinkages and the total cost is distributed. The details of boiler room cost are shown in Table II. Each item is a percentage of the total.

The boiler and grate efficiency is based on the total evaporation and the average coal analysis for the month and includes all banking and starting losses. The total steam delivered is also shown in pounds per 24 hours. The turbine room cost detail is shown in Table III. The total kilowatt-hours generated minus the kilowatt-hours to the auxiliaries gives the kilowatt-hours delivered. Again the items are shown as percentages of total cost. The pounds of coal per kilowatt-hour gives a basis for comparing costs.

TABLE II—BOILER ROOM COST DISTRIBUTION IN PERCENTAGE OF COST PER 1,000 POUNDS OF STEAM

	Monthly Readings			Yearly	
	Jan.	Feb.	March	1924	1923
600 Supervision	0.58	0.64	0.65	0.79	0.70
602 Firemen	2.18	2.20	1.98	2.20	1.90
603 Cleaning	0.30	0.25	0.19	0.24	0.17
604 Coal and ash handling	1.30	0.87	0.81	0.96	1.01
605 Miscellaneous labor	.....	.....	.....	.....	0.02
610 Switching loco. and crane	1.80	1.84	1.87	1.43	1.25
615 Service charge on cars	.....	.....	.....	.....	0.13
625 Miscellaneous supplies	0.15	0.08	0.12	0.20	0.17
625 Fuel, freight and shrinkage	71.30	68.52	70.53	63.50	70.05
628 Oils	0.20	0.21	0.28	0.21	0.07
629 Charts and inst. supplies	0.06	0.04	0.04	0.04	0.10
650 Maintenance miscellaneous	0.26	0.24	0.09	0.17	0.19
651 Main. bldgs. and grounds	.....	0.25	0.25	0.06	0.06
652 Main. auxiliaries	0.14	0.22	0.32	0.73	0.66
653 Main. piping	0.66	0.38	0.67	0.53	0.92
654 Main. instruments	.....	0.05	.....	0.04	0.20
660 Main boilers	0.10	0.13	1.27	0.74	2.90
662 Main. furnace	0.22	0.26	0.73	0.09	0.09
663 Main. stokers	0.22	1.83	0.34	1.70	1.88
664 Main. coal-handling equipment	0.03	0.09	0.04	0.81	0.34
Fixed charges	7.51	8.04	7.26	9.10	5.79
Interest at 7 per cent	12.99	13.86	12.56	16.50	11.40
Total	100.00	100.00	100.00	100.00	100.00
Net steam delivered, 1,000 pounds	84,364	79,333	89,546	634,281	803,806
Boiler and grate efficiency, monthly average	72.6	69.5	69.0	72.2	72.2

The reading of high-pressure steam-turbine meters plus $\frac{1}{16}$ low-pressure steam induced minus $\frac{1}{16}$ low-pressure steam extracted gives the steam used by the turbines for the foregoing calculation. The ratio of this to the total steam delivered gives the percentage of coal charged to the turbines. The quantity divided by total kilowatt-hours delivered gives pounds of coal per kilowatt-hour. The current generated under these conditions with cost figured as shown gives a cost per kilowatt-hour about $\frac{1}{16}$ of a cent less than it would be if purchased from the local public service company.

The water evaporated, the steam generated and the steam delivered check within 10 per cent for monthly readings. Low-pressure meters particularly on injection and extraction turbine connections are subject to possible errors due to very short straight runs of pipe and variation in steam pressure. The balance of low pressure in and out of the power house shows a variation of about 20 per cent.

TABLE III—TURBO-GENERATOR ROOM COST DISTRIBUTION IN PERCENTAGE OF TOTAL COST PER KILOWATT

	Monthly Readings 1925			Yearly Readings	
	Jan.	Feb.	March	1924	1923
700 Supervision	1.27	1.23	1.17	1.39	1.20
702 Operators and oilers	3.50	3.10	3.29	3.86	2.75
Steam	48.13	51.30	57.83	49.20	63.05
705 Miscellaneous non-prod. labor	.....	.....	.....	.....	.....
725 Miscellaneous supplies	0.12	0.12	0.09	0.11	0.10
728 Oils	0.51	0.32	0.71	0.29	0.28
729 Charts, etc	0.12	.....	0.06	0.08	0.01
750 Miscellaneous maintenance	.....	.....	.....	0.07	0.45
751 Buildings and grounds	.....	.....	.....	0.01	0.17
752 Auxiliary maintenance	.....	0.05	.....	0.25	0.02
753 Piping maintenance	.....	.....	0.07	0.04	0.46
754 Instrument maintenance	0.04	.....	.....	0.06	0.01
760 Prime mover maintenance	0.05	.....	.....	0.30	1.43
761 Generator and switchboard	0.02	.....	.....	0.10	0.95
Fixed charges	15.24	14.48	12.13	15.01	8.11
Interest at 7 per cent	31.00	29.40	24.65	29.23	21.01
Total	100.00	100.00	100.00	100.00	100.00
Kw.-Hrs. delivered	1,467,290	1,587,910	2,084,750	15,649,860	19,944,300
	Jan.	Feb.	March	1924	1923
Pounds of coal per kw.-hr.	2.35	2.13	2.02	1.93	2.29

Some British Steam Engine Accidents

THE technical report of the British Engine, Boiler, and Electrical Insurance Company contains an account, among others, of the following failures:

A twin, horizontal, tandem-compound condensing engine, with cylinders 19⅛ in. and 44 in. in diameter by 6-ft. stroke was built in 1890 to operate at a speed of 52½ r.p.m. and with a steam pressure of 165 lb. The crankshaft was 19 ft. 6 in. long, the journals being 16 in. in diameter and the swell for the flywheel 22 in. in diameter. Overhanging crankarms were shrunk on to the ends of the shaft, which was bored throughout its whole length with a 5¼ in. hole.

Fractured Shaft

As oil was seen to be trickling from both ends of the hole in the shaft, an examination of the journals was made after the engine was stopped for the week-end. A serious fracture was found at the fillet, on the flywheel side of the left-hand journal; the crack could be seen traveling circumferentially for a length of 28 in. On the shaft being turned, the surfaces at the fracture sprung apart and oil oozed out. After the removal of the shaft it was found that the brasses and the seats on the pedestals for carrying the bottom step, were fractured in many places, the cracks in some cases having opened up $\frac{1}{16}$ inch.

Microscopic examination of the material showed that, although the steel was not particularly clean, there were no outstanding inclusions. Sulphur prints showed that the sulphur content was evenly distributed and did not form segregations. A microphotograph taken at 80 magnifications showed that the structure was coarse and angular, pointing to the fact that the steel had been somewhat overheated; a microphotograph taken at the higher magnification of 500 showed that the pearlite was almost entirely globularized, a structure found in large masses that have been cooled down too slowly through the temperature range immediately below the carbon change point, or in bodies that have been soaked in the furnace at this temperature for an excessive period. This structure is associated with a

very low value of the elastic limit. The metal of the shaft had been weakened by a so-called annealing treatment, probably carried out after rough machining.

The heating of the journals was caused by the warping of the bottom brasses, owing to their exceedingly light construction. The side brasses, which did not show undue signs of wear, were only 1 in. thick. The bottom brasses at the time of the failure were only ⅞ in. thick and it is probable that the thickness had never exceeded 1 in., an altogether insufficient allowance for bearings 39 in. long carrying a massive flywheel.

Unaflow Cylinder Cracks

In another case, while running light at midday, the engine suddenly stopped. It was found that the flywheel could not be barred round by hand. The cylinder end cover was removed, after which it was seen that the piston had seized; and upon its being withdrawn, the cylinder was found cracked. The line of fracture passed completely around the circumference, traveling through the exhaust ports. The cylinder was severely scored at both ends and the piston also to a lesser degree.

The trouble was caused by faulty lubrication. An examination of the lubricating system showed that all the needle valves for regulating the oil supply, with the exception of one, were out of order. Owing to the gradual wear of the valves the springs had been tightened till the turns of the coils practically touched and the lift was in consequence reduced to a negligible quantity. One lubricator was choked with deposit to such an extent that it would not leave its seat.

It was also discovered that, owing to wear, the original cast-iron piston had been replaced by one made of cast steel. The use of this material, which is unsuitable for the piston of a horizontal engine, in all probability aggravated the lubrication trouble.

When tested by the insurance company, the oil was found to be of first-class quality and in every way suitable for use with superheated steam.

The new cylinder installed was provided, as a precautionary measure, with an extra flush lubricator at each end.

Connecting Rod Bolt Fails

Another serious smash was the result of a failure of a connecting-rod bolt of an engine. These bolts were made without any fillet between the stem and the head, and in fact no allowance for fillets had been made when the cap was recessed for the heads of the bolts.

The structure of the material had been ruined by the annealing treatment having been most improperly carried out in a tinplate furnace. The treatment, instead of annealing the material, obviously did the reverse. The bolts were soaked for 1½ hours, a quite unnecessarily long period, at a temperature unrecorded in any way, after which they were cooled on the floor.

The insurance company strongly condemned the heat treating of bolts, shafts or other parts by rough-and-ready methods.

The malpractices, which take place when "annealing," have arisen owing to the prevalence of a vague idea that it is possible to restore metal that has been overstrained in service to its original condition by some form of heat treatment. As in other directions, a little knowledge is a dangerous thing, and if it were realized that an incorrectly carried-out operation is likely to damage or even ruin steel, the ordinary owner would no doubt give it up.

Combustion Processes in the Oil Engine

By H. F. Shepherd

TO THE average engineer there is no intermediate step between the introduction of a charge of oil into the engine cylinder and its complete combustion. Nevertheless the process is quite complicated, and just what does take place is by no means known with definiteness.

In fact, the oil-engine industry needs more knowledge of the process. Perhaps there is little ground for the hope of much improved economy in the use of the fuel; however, we can hope for less waste in fruitless experiment and a general reduction of fuel consumption by elimination of faulty oil-engine types. Knowledge of every reaction to which the fuel is subjected in passing from the liquid state to the products of combustion will accelerate the work.

The very volatile petroleums, now seldom used unmixed as fuel, act much the same as gas in the internal-combustion engine. Heavy fuel, which can be burned only in the injection engine, behaves differently. In the short interval of about one-hundredth of a second from the beginning of injection to the moment of ignition and in the ordinarily shorter time between ignition and the rise to full pressure, the fuel undergoes treatment which makes possible the complete union of its elements with oxygen.

Principles of Cylinder Design

Briefly, the principles determining the mechanical design of the cylinder are not numerous nor are they novel, and any departure from them seems only to result in renewed confirmation of their correctness.

In the solid-injection engine there is no means of producing an oil fog of such perfection as is produced by air injection, and it is not necessary to do so. The minute drops of oil are not carried in on an energized vehicle. They must by virtuue of their own mass and velocity carry from the nozzle to the desired location.

The combustion-chamber air temperature or its wall temperature, if the spray strikes metal, must be such that at the interval of injection ignition does not take place instantly. This momentary delay is aided by the incomplete state of compression at the beginning of injection and by the latent heat of vaporization of the fuel. If inflammation of the minute drops takes place before preparation, the smoky combustion of a body of oil burning upon the surface naturally results. While gas-engine ignition proceeds from one or more points by flame propagation, oil-engine ignition is spontaneous; it may break out in a large volume or over a large area at once.

When burning heavy oil, the combustion chamber is essentially a retort. From this angle it is at once evident that possibilities practical and impractical are many. Oil cracking is at once suggested. Perhaps we have used the word a little too glibly, for no one

has devised proper laboratory apparatus to demonstrate oil-engine reactions.

In the case of solid-injection engines the maximum temperature available before ignition is probably about 950 deg. F. For any given load it is the designer's care to preserve proper temperature values, and this is done quite successfully. Fuels containing free-boiling fractions will absorb a considerable amount of latent heat in their primary vaporization. Heavy fuels, with the same maximum temperature available, regardless of what quantity of heat may be stored in the hot surface or air charge, will vaporize less and will, therefore, extract less heat. Alcohol with its very high latent heat, high specific heat, low critical temperature and high critical pressure will absorb far greater quantities of heat.

Fuel Preparation

It is known that the fuel is not atomized in the absolute sense. It must, therefore, be vaporized and diffused either by artificial turbulence or by that produced by explosion, or intensive dissociation of the hydrocarbon must occur before mixing can be sufficiently intimate for good combustion. Slow distillation, as by injection during the suction stroke, is fatal to good combustion. This was demonstrated years ago. Yet we must subject the unvaporized heavy fractions of the fuel to cracking conditions after the previously vaporized light fractions are consumed at nearly constant volume. Perhaps only after this are the best conditions set up for a sufficiently rapid reaction to crack the residues. Such reactions are enormously accelerated at very high temperatures. That there has been no successful attempt at burning heavy petroleum fuel at constant pressure with solid injection is probably explained by this fact. Engines employing dual-combustion chamber are not an exception. They are generally indicated by connection with the power cylinder and therefore give constant pressure diagrams. If the indicator be applied to the primary combustion chamber, very much higher pressures are realized and the pressure rise has an explosive character. In this case the more volatile fractions furnish the motive power for blasting the residues into the main combustion chamber.

Dual-Combustion Engines

The modern solid-injection engine is often referred to as operating on a mixed cycle, inasmuch as the indicator diagram shows burning partly at constant volume and partly at constant pressure. This is not to be taken too seriously. The shape of the diagram will vary with the fuel and the piston speed, and in any event the entire fuel charge is usually in before or at dead center. The shape of the diagram after dead center is not under control of the engine mechanism.

The efficiency of combustion is governed by the percentage of free boiling fractions in the fuel. If this fraction is relatively large, high economy results. If most of the oil is slow boiling, the consumption may be increased 10 per cent, regardless of the heat value of the fuel. If the free-boiling fraction is altogether insufficient, as in the case of certain Mexican residuums, satisfactory operation may be impossible without admixture of lighter oil.

The thought of combustion in two phases is not novel when one considers how the volatiles in coal support combustion until the carbon is glowing.

District Heating by Waste Heat from Diesel Engines

In *Die Wärme* of June 26, H. Doevenspeck reviews the development of methods for utilizing waste heat from internal-combustion engines, and states that there is now hardly any large gas engine the waste heat of which is not utilized. Tests with circulating water at temperatures from 120 to 212 deg. F. showed that the mechanical efficiency of Diesel engines was increased and the fuel consumption reduced as the temperature of the water increased.

Formerly, the cooling water of the Diesel engines in the Schwerin Electricity Works was rejected at 120 deg. F. and the hot exhaust gases escaped into the open. Now, however, the water leaves the engines at 176 deg. F. and the exhaust boiler at 185 deg. F., and is circulated by pumps through a district heating system, the pipes of which extend to a distance of 4,000 ft. The ground is fairly level, and this is an important consideration where the circulation of water is concerned. The go and return pipes are laid side by side in underground ducts and are provided with rollers and expansion loops. With engines totaling 3,740 hp. the maximum capacity of the installation is about 14 million B.t.u. per hour. Two hot-water storages, each of 1,770 cu.ft. capacity, are used to save surplus hot water from the evening peak for use next morning and during the day. Two coke-fired boilers are installed for use in case of emergency. Should the water return at too high a temperature from the heating circuit, it can be cooled to 140 deg. F. by a cooler provided for the purpose.

The effective heat recovered from the circulating water and exhaust gases represents 38 per cent of the calorific value of the fuel burned by the engine. During the summer the recovered heat may be used by means of a low-pressure turbine, or if the amount of steam available from practicable pressure reduction on the water be too small, other uses may be made of it, such as in an absorption refrigerating plant. The district heating described is applied to nine large buildings, saves about 20 per cent on the former cost of heating these and returns at least 10 per cent on the cost of its installation.

It appears possible to determine approximately the amounts of severe stresses applied to some steels by examining the structures through etching processes. Experiments by J. Dudley Jevons, in a paper presented at the Iron and Steel Institute, May 7, 1925, described many patterns obtained after physical tests that differed according to the character of the test. When a machine element is guaranteed to meet a specified tensile load and has been nevertheless subjected to a serious excess of guaranteed load, it may be possible eventually to prove such an undesirable stress by an etching process.

If hydrochloric (muriatic) acid is placed in a bottle having a bent glass outlet tube passing through the cork and ending close to the bottom, a second tube may be inserted through the cork so that one may blow air into the bottle. This drives some of the acid out in the form of a mist. If this is done along an ammonia pipe suspected of leaking and if any ammonia is present, white fumes will appear. Care should be taken that the acid does not come in contact with eyes or skin.

The Twelve Hundred Pound Plant

THREE years ago the 1,200-lb.-pressure steam plant was to most engineers but an idle dream. Today it is about to become a sober reality. It is fortunate that an idea possessing such merit on paper is to meet its practical test under the most favorable auspices—that it need not perish for lack of substantial nourishment, as have so many good ideas in the world's history. For the high-pressure installation now nearing completion in the Weymouth Station of the Edison Electric Illuminating Company of Boston is not the handiwork of impractical visionaries. Behind the 1,200-lb. boiler and turbine are powerful organizations with extensive manufacturing experience in these fields. Specialized skill has been made available for such operations as the forging of the seamless boiler drum from a single ingot and the X-ray testing of steel castings for the turbine shell. Expert knowledge has been brought to bear on such small but vital elements as safety valves and gage glasses. In short, all has been done that is humanly possible to insure the successful working of the 1,200-lb. installation. Nor do design and construction tell the whole story by any means. It is a fortunate circumstance that this pioneer installation will be handled by as capable a staff of operating engineers as can be found anywhere.

Yet Weymouth has not put all its eggs in this one basket. With recognition of the potential difficulties existing in all radical departures from existing practice, the station is constructed as a self-sufficient 350-lb. plant with superimposed 1,200-lb. equipment. If trouble should be experienced with the 1,200-lb. boiler or turbine, or both, the 350-lb. equipment would insure operation with a slight reduction in over-all station capacity and efficiency.

How this is to be accomplished was described in the April 14 issue of *Power* and is summarized in the leading article of the present issue, which is particularly concerned with the details of the high-pressure boiler and turbine.

It is too early to say whether 1,200 lb. will show a higher commercial economy than pressures around 500 lb. for the conditions of fuel and construction costs, load factor, etc., surrounding the average large central station. There is, of course, no doubt of a substantial saving in fuel.

Whatever the ultimate developments along this line may be in the field of central stations, the satisfactory mechanical operation of a 1,200-lb. boiler and turbine is almost certain to have far-reaching consequences in other directions. Ever since engineering thought began to focus on the possible gains from higher steam pressures, it has been realized that these would be far greater for what European engineers call "back-pressure" plants than for stations operating with the high vacuum customary in central-station practice. Where the turbines exhaust to process at atmospheric pressure, the raising of the throttle pressure from 200 or 300 to 1,200 lb. will materially increase the "byproduct" power obtainable from a given flow of process steam. With process pressures of 50 to 100 lb., such as are used in some industries, the percentage gain is astoundingly large.

It may therefore be expected that the more progressive manufacturers of pulp, paper, rubber goods, textiles, chemicals, etc., will watch the Weymouth experiment with particular interest, keeping in mind the possibility of installing boilers and turbines to operate at extremely high pressures in these industries wherever sufficient power for manufacturing cannot be generated from the process steam alone at the present boiler pressures.

In this connection the steam accumulator may be enlisted to store process steam at moderate pressures, relieving the boiler of extreme load variations and tying together power and steam demand curves that do not synchronize.

A Lesson from the "Mackinac"

WHILE the Examining Board of the Steamboat Inspection Service has not rendered its verdict in the trial of the "Mackinac's" engineers for operating a boiler when knowing it to be in a dangerous condition, it is impossible for the average citizen not to draw certain conclusions.

Whether the boiler actually had a crack in the drum before the boat sailed is a question of veracity between the chief engineer and the boiler repair man. In fact, while blame for the disaster should be placed against the rupture of the drum, the underlying causes were touched upon but slightly at the trial.

When this boiler exploded, examination of the drum revealed that the original shell thickness of $\frac{3}{8}$ in. had been reduced by corrosion to approximately $\frac{1}{16}$ in. The inspector at New York had examined this boiler in April and has testified that not only was a hydrostatic test made, but the hammer was used over the entire boiler and that the drum was given especial attention. It is inconceivable how a plate that was but $\frac{1}{16}$ in. thick in August could have passed such a test in April. A mere tyro in boiler inspecting should have been able to discover the condition of the shell if the hammer was actually used over the corroded section. A witness, the owner of a boiler works doing marine work, testified in the trial that it was a common practice for vessels to be sent to New York City as the inspection was less rigid there than at other ports.

The design of the boiler was such that there was no access to the drum. Why the owner, the engineer and the boiler inspector did not see that handholes were placed in the ends is a question that requires an

answer. The water legs were renewed three years ago. Was the drum in a sound condition at that time? Why were not openings made in the new legs to permit inspection of the drum?

Many of the disastrous boiler explosions in the past have been due to cracks along lap seams. A leak along such a seam is always a danger signal, and the engineer in disregarding such a warning reveals that he either was not competent as an engineer to appreciate the gravity of the leak in the drum or possessed a take-a-chance point of view, either of which should have precluded his possession of a certificate qualifying him to take charge of machinery upon the condition of which depended the lives of hundreds.

Not So Bad As It May Appear

THE induction motor, although the most reliable and simplest type of motor developed for industrial service, has come into more or less bad repute on account of its power-factor characteristics. Low power factors of power systems are not altogether due to the induction motor. The lack of proper consideration to its applications has been an even larger factor. If, on account of not knowing what power the duty cycle of a load requires, a motor of two or three times the capacity necessary to do the work is installed, the machine should not be blamed for the human shortcomings. In many installations material improvements have been made in the power factor by rearranging the motors so as to get them more nearly loaded and substituting new motors for a few that, on account of their size, could not be properly applied. What was accomplished in the rearrangement of the motors should have been done at first and the expense of the change saved.

Contrary to the general opinion, the power factor of a normal induction motor at full load or even at half load would not be considered low. For example, a ten-horsepower sixty-cycle induction motor operating at about eighteen hundred revolutions per minute has a power factor of about ninety per cent at full load and eighty per cent at half load. Either of these would be considered fairly satisfactory on most power systems. It is the low-speed motor that has a poor power factor. A ten-horsepower sixty-cycle motor designed to operate at six hundred revolutions will have a power factor of less than eighty per cent at full load and less than sixty at half load. It is evident that slow-speed induction motors are to be avoided where possible, especially if they are to operate at part load. If there is no other solution to the motor application than using a slow-speed induction motor, then some means should be provided to compensate for the power factor of the slow-speed motor.

A few years ago there may have been more or less justification for some of the induction-motor applications that were made. The synchronous motor has now been so improved and new types made available that in most applications not well adapted to induction motors the former can be satisfactorily used. In most plants no one type will meet all the different conditions, and it is a case of selecting the type best suited to the various applications, so as to obtain the most economical arrangement. To do this requires an intelligent understanding not only of the load cycles, but also of the characteristics of the motor available for the service.

Patent Office Improvement

FOR many years the Patent Office in Washington has been a major source of complaint against the government, especially with those who had direct dealings with that office. There is good reason to believe that the present reorganization is going to result in a vast improvement in the method of handling patents, at least through the Patent Office. Before the present reorganization was started, about two years would elapse after an application had been filed before it would be considered. This period has been reduced to about three months. The recent recommendations by the Committee on Patent Office Procedure that the technical staff should be increased by one hundred examiners and the appointment of an administrative assistant to the Commissioner of Patents, along with other changes, should do much to improve conditions further.

Consideration of the application is far from the granting or disallowing a patent, as has been the experience of those dealing with the Patent Office. Under the old arrangement undoubtedly the examiners were overloaded with work to an extent that did not allow them to give the necessary consideration of each application. For this reason there were many delays and unnecessary controversies over claims in the application, that never would have occurred if more careful study had been given them at first. Letters received by patent applicants from patent examiners have shown that the examiner had not carefully read the claims in the application, or if he had, he was not competent to judge them. If the examiners are not competent to judge the claims or under the pressure of work, have not time to give them the study necessary to pass intelligent judgment, then many questions that should be settled with the examiner will be carried to the Board of Examiners or Commissioner of Patents. Such a condition makes their positions more difficult.

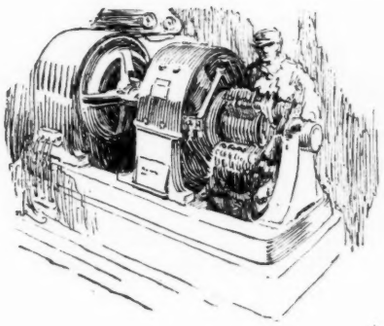
This emphasizes the necessity of obtaining competent men for examiners, which, with the salaries paid government employees, is not always easy to do. Whenever anyone has attempted to give a Government Department a real business organization, he has always been confronted with the problem of how to obtain the right kind of men and women to fill the important positions at the salaries allowed. In the present reorganization of the Patent Office this handicap also exists.

Free Air

"FREE AIR" is a sign familiar to every patron of the wayside gas stations. While free air is all right in its place, some plant owners would make more profit if their boiler rooms were boxed up airtight, with all air admitted through a meter and charged for at a nominal rate.

To burn one pound of average coal requires theoretically about one hundred and thirty cubic feet of air—or, say, around one hundred and ninety cubic feet in typical well-operated plants. Suppose that, owing to carelessness, two hundred and sixty cubic feet are used, a needless excess of seventy cubic feet per pound of coal. In a plant burning fifty tons of coal per day this amounts to seven million cubic feet of air per day unnecessarily heated about five hundred degrees and then thrown away, a loss equivalent to two or three tons of coal. If the plant were billed for this air, the operators might not use it so freely.

Practical Ideas from Practical Men



WITH a view to stimulating engineers into the habit of recording for the benefit of brother engineers, unusual occurrences, how these were met and other practical expedients adopted in the operation of their plants, Power has decided to award two cash prizes each month during 1925. One of $25 for the best and another of $15 for the second best practical letter on plant operation or practical kinks received during the month. This is in addition to payment for the contribution at space rates. The winners for July will be announced this month.

Maintaining a Proper Steam Supply to the Different Processes

On automatic temperature controllers that are not equipped so that they will shut off the steam to the different processes when the air pressure fails, the temperature will tend to rise rapidly. We overcame this trouble by installing a valve in the main steam pipe that was held open by the air pressure, as illustrated in Fig. 1. As long as the air pressure is maintained, the valve is held open, but should the air pressure fail for any reason, the tension spring on the valve stem causes the valve to close. The spring can be adjusted to shut the valve at any desired pressure. A bypass is provided for emergencies.

This arrangement prevented the temperature from going up but not from going down on the bleach tubs at night. At first we had a bell that would ring if the

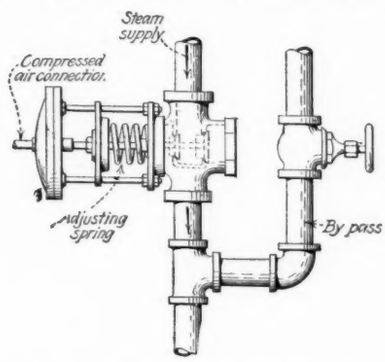


Fig. 1—Valve in steam line to bleach tubs closes when air pressure fails

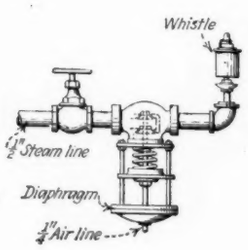


Fig. 2 — Valve admits steam to whistle if air pressure fails

air compressor stopped or the air pressure failed for any reason, but the watchman could not hear the bell if he was in some other part of the mill, so a whistle was installed, it being connected to the steam line as shown in Fig. 2. In this case the valve for admitting steam to the whistle is held shut by the air pressure acting on the diaphragm, but should the air pressure fail, the tension of the spring opens the valve and admits steam to the whistle. The blowing of the whistle warns the watchman that the air pressure has failed, and he at once investigates and gets the service back to normal.

GORDON M. PHINNEY.

Needham Heights, Mass.

Cutting Production Costs by Changes in the Power Plant

In the paper industry there are perhaps more opportunities for cost reduction in the power plant than in any other type of plant, owing to the fact that a twenty-four hour load exists and a large demand for process steam. This is especially true of the medium-sized and small mills having a daily output of ten to thirty tons of paper. The power requirements of these mills run from 300 up to 700 hp., and taking 500 as the average, the daily coal consumption is around twenty tons. With an average evaporation of 8 lb. of water per pound of coal the hourly steam flow is 13,333 lb. This is apportioned among the various units as follows: The main engine uses 400 hp. and the paper machine engines use a total of 100 hp., utilizing most of the steam. The water rate of the paper machine engines, which are of the slide-valve type, at 130-lb. steam pressure and 10-lb. back pressure is around 55 lb. per hp.-hr., which gives a steam flow of 5,500 lb. per hour to the machine room. The main engine, usually a simple engine running condensing, has a water rate of about 18 lb. per hp.-hr., which shows the steam consumption to be 7,200 lb. per hour. This gives 12,700 lb. per hour for the engines, and the balance of 633 lb. per hour is used by the feed pump and condenser pump. The exhaust from the paper-machine engines is used in the driers, and any excess is used to heat feed water, the feed temperature being anywhere from 160 deg. F. to 212 deg., depending on whether there is any excess exhaust from the machine room. At times all the exhaust is condensed in the driers and the only exhaust steam available for feed heating is that of the condenser and feed pumps. In plants of this kind a large saving could be made with a small investment by following the plan described herein.

Owing to the fact that 5,500 lb. of steam per hour must be used at low pressure for process work and feed heating, it is possible to develop 200 hp. on this amount of steam by passing it through an engine whose water rate is only 27.5 lb. per hp.-hr., thus getting twice as much power from this steam as can be got under existing conditions. If we use motors to drive the paper machine and operate the main engine at 10-lb. back pressure to exhaust into the driers, we can develop 200 hp. with the process steam. This leaves 300 hp. to be developed in a condensing engine, and if we select a unaflow engine of the most efficient type we can get a water rate of 13 lb. per hp.-hr. In this way there is

only 3,900 lb. of steam per hour discharged to the condenser where under present conditions 7,200 lb. is used. The condenser loss is cut nearly in half by this method and a considerable reduction in the steam used by the condenser pump and feed pump is possible. With a total steam flow of 9,400 lb. to the engines instead of 12,700 as at present, the steam consumption of the pumps can be reduced by 25 per cent. The total steam flow will then be 9,875 lb. per hour as compared with 13,333 lb., a saving of 25 per cent of the fuel cost resulting from this change. Now, the next thing to consider is whether this saving is large enough to justify the investment required to produce these economies. Operating 300 days a year and paying $7 a ton for coal, brings the annual fuel bill up to $42,000, and a 25 per cent saving amounts to $10,500 a year.

A unaflow engine could be installed for $14,000, and one prominent engine builder makes a practice of installing his engines on a cash payment of about 25 per cent of the purchase price and allows the buyer to pay the remainder out of the savings effected by the engine. Thus an initial investment of $3,500 (25 per cent of $14,000) would secure the engine and the fuel saving of $10,500 would pay the remainder of the engine cost in one year of operation. The investment in electrical equipment would be the cost of motors totaling 100 hp. for the paper machines and a generator of 85 to 100 kw. capacity to generate current for the operation of the paper machines. Good second-hand motors could be obtained for $12 per hp., and $1,200 for motors plus an equal amount for the generator would limit the investment to less than $2,500. Inasmuch as the paper machines in these mills are in many cases over twenty years old, I question the advisability of purchasing new electrical equipment for their operation, which would call for an investment of about 2½ times what second-hand equipment would cost. Thus the total investment called for is $3,500 + $2,500, a total of only $6,000 and the return is greater each year than the entire investment. Even after allowing 13 to 15 per cent fixed charges, the equipment earns an annual dividend of over 150 per cent. Surely, any plant owner who is alert and interested in cutting production costs should investigate the possibilities offered by this method.

Springfield, Mass. A. F. SHEEHAN.

Preparations for Rebalancing a Small Turbo-Generator Set

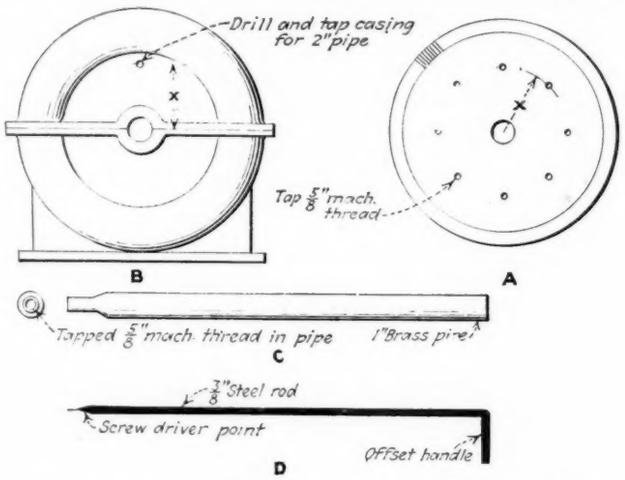
A few years ago I had occasion to reblade a 1,000-kw. impulse non-condensing back-pressure turbine. It was of the rigid-frame type with a single-bucket wheel. The wheel casing and connection piece were split horizontally.

Before lifting off the upper half of the wheel casing, it was necessary to remove the upper half of the connection piece from turbine to generator, the tops of the packing boxes, packing, the synchronizing device and the governor casing. Renewing the blading and shroud bands was not a difficult operation, but balancing the set was where our troubles began.

Originally, at the factory all the rotating parts were balanced statically and then dynamically. What balancing the wheel itself needed was done by chipping from a strip on the inside of the bucket wheel rim. After the new blading was put on and the machine reassembled, it was found to be too badly out of balance to be corrected by adjusting the end weights where provision had been made for balancing the rotating element.

To balance by chipping the wheel meant taking the upper half of the wheel casing off each time and the upper half of the connection piece, with the probable chance of breaking some of the carbon packing. Also a good half day's labor with our hand crane would have been necessary.

Consequently, some easier method had to be found. After again removing the wheel casing, eight holes were drilled in the wheel by means of an air motor and were tapped for ⅝-in. machine threads. These holes were about 8 in. from the rim and all of the same radius from the center of the shaft. They were spaced at



Wheel and casing drilling with tools for handling turbine balancing weights

equal distances around the wheel as shown in the figure at *A*.

In the exhaust end of the wheel casing at a similar radius from the shaft center a 2-in. hole was drilled by the same means, and this was tapped to take a 2-in. pipe plug.

A piece of brass pipe *C* long enough to reach through the hole in the casing to the wheel with about 6 in. remaining outside was obtained. One end of this pipe was drawn small enough to be tapped for ⅝-in. machine threads.

A ⅜-in. steel rod about 8 in. longer than the pipe was next obtained. One end was flattened like a screwdriver and the other about 6 in. from the end was bent at right angles for a lever, as at *D*. For weights we used ⅝-in. stud bolts of various lengths with slots milled in one end. For some of the smaller weights it was necessary to cut the stud bolts in two, using the all-thread end.

A weight was first screwed into the pipe with the slotted end inside. The pipe and long rod were then inserted through the hole in the casing and the weights screwed into the wheel. The locations and numbers of the holes in the wheel were shown by corresponding white marks on the coupling between the turbine and generator.

By this means the unit was balanced in a little over one day. As soon as the balancing was done, the casing was again removed and all the weights withdrawn, graphited and pulled up tight again with a wrench.

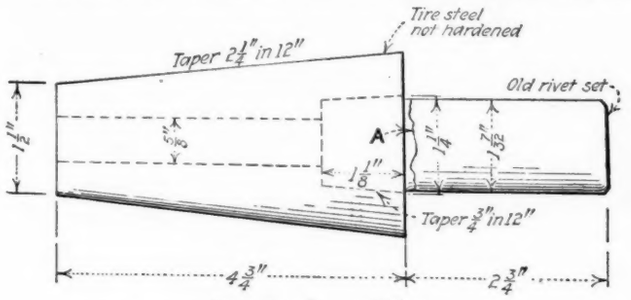
V. R. CHADBOURNE.

Beaumont, Tex.

Two-Piece Flue Expander

The illustration shows a two-piece tube expander, which we have found to be a big improvement over the one-piece tool formerly used. The expanders were formerly turned up from one piece of stock and tempered, and they would invariably fracture in the shank at the point *A*.

To overcome this trouble we tried making them in two pieces by taking an old rivet set and turning a



Detail of expander

taper on the end to fit the body of the expander, thus making a separate shank. We now get about six months use out of an expander, whereas we got about a week with the one-piece tool. J. WEIR.

San Bernardino, Calif.

Using Marked Wires in Motor Installations

When wiring up motors I have found it a convenient practice to use marked wires, particularly in the smaller size. For fractional-horsepower motors that connect directly to the line, without a starting device other than a switch, this does not make much difference as there are only two wires and they do not have to be identified before connecting to the motor.

In the small sizes of direct-current motors using a starting box I use a duplex and a single wire, when duplex of sufficient size can be obtained. The two wires of the duplex are of different colors and are therefore easily identified at either end of the conduit without testing, as is also the single wire. It is the practice to use condulets on the end of the conduit. At the motor the wires pass through a porcelain cover with three holes. The condulet is located at the motor at the most convenient position, and the conduit is sometimes secured to the motor. I always use the white or marked wire of the duplex for the armature, the other wire of the duplex for the line and the single wire for the field connection. The field wire is always brought out the middle hole in the porcelain. In cases where all the wires are of the same color, I use the hole in the porcelain nearest to the commutator as the armature wire, the other end hole as the line but the field wire always remains in the middle hole under all conditions. If the conduit is terminated at the motor in such a way that both end holes in the porcelain on the condulet are equally spaced from the commutator the hole at the right-hand side when facing the motor from commutator end is used for the armature wire, when all wires are of the same color.

On medium- and large-size motors, single wires must be used so that they are all of the same color. Before pulling these wires into the conduit each end of one of the large leads is marked for the armature wire.

The conduit should not be supported from the motor screws, since should the motors have to be temporarily removed for repairs the conduit would hang loosely, although it could be tied up until the motor is replaced. It is a much better practice to secure the conduit independent of the motor. The motor-outlet condulet should not approach the motor nearer than 6 or 8 in. so that ample room will be available for making connections. To prevent water or other liquids entering the condulet the wires should come out of the condulet horizontally or better still vertically downward.

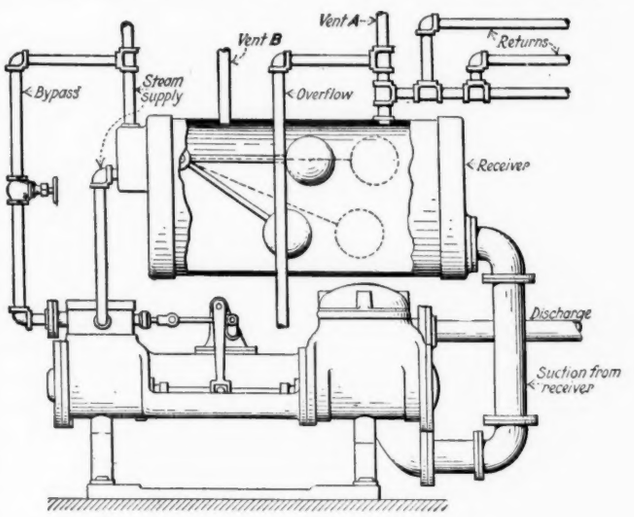
New York City. ALBERT A. A. RODRIQUES.

Experiences with Steam Pump and Receiver

The illustration shows the general arrangement of a receiver and pump, which was used to take care of all the returns from the heating system and other services in a plant where I was formerly employed.

As will be seen, the steam supply to the pump is controlled by a float inside of the receiver. As the receiver was not large, it necessitated careful adjustment of the valve, and in fact, at first it was practically impossible to get it adjusted satisfactorily. With the float in the highest position the pump would not get enough steam, and when in the lowest position it would not shut the steam off sufficiently to prevent the pump draining the receiver.

Upon making inquiry, I learned that the original float supplied with the receiver had been damaged and was replaced with one purchased from a junk shop.



Arrangement of pump and receiver

This being the case, I decided to get a smaller float and shorten the float rod 6 or 8 in. to give the valve more travel. This removed the trouble entirely.

In another plant I encountered a different trouble with the same type of receiver. The vent was at the top of the vertical riser into which the returns and overflow were connected as at *A*. With this arrangement every time a certain tank was blown down or there was an extra rush of water to the receiver, the vent would become sealed and the water would rise and pass out the overflow instead of into the receiver. A vent connected directly to the top of the receiver as at *B* remedied the trouble. C. M. PHINNEY.

Needham Heights, Mass.

Comments from Readers

College Entrance Requirements for Engineering Students

In the Aug. 4 issue, David E. Davis discusses college entrance requirements for engineering students. He advocates a more rational selection of entrants on the basis of their probable ability to become desirable members of the engineering profession and the weeding out of those who are unlikely to become such.

Of course this throws a tremendous responsibility upon those who make the selection, but no doubt there should be more weeding out. There are entirely too many students coming into a college from an accredited high school who are not prepared to start any college course, much less an engineering course. They drift along for a year, maybe two or three, before they finally realize that they are in the wrong procession. Some of them never do find it out.

Their failures are usually due to a lack of proper grounding. They have had too many educational frills and too little of the simple fundamentals. This applies not only to students entering college, but to those who for one reason or another start to work without finishing high school or sometimes even grade school. Lack of a proper knowledge of simple arithmetic has seemed to me to be the most common fault.

I recall two typical cases of boys in engineering work who had been forced to stop school after finishing two or three years of high school. Being ambitious to get ahead as engineers, they enrolled in an evening school. Signing up for "advanced algebra" on the strength of their high-school records, they started to wrestle with a, b, c, x, y and z. But they ran into all sorts of difficulties; couldn't get the stuff through their heads. Why? They were intelligent boys, but they had never been taught enough arithmetic. Just plain simple arithmetic—one of the headliners in the days of the three R's, but no longer a headliner.

If these boys added 2 and 3, they were likely to get 5, and if asked to take $\frac{1}{4}$ of $13\frac{3}{4}$, they were completely lost. Problems that every engineer runs into every day and that a fifth-grade student should be able to do instantly, were beyond their depth, and yet they were full-fledged students in "advanced algebra." I persuaded both to drop this course and to go back and take a course dignified by the name of "mathematics review," which was really plain arithmetic.

And this is just what about half of the students entering college to take an engineering course should do. A preliminary examination that would separate the half qualified to go ahead from the half lacking in the knowledge of these simple fundamentals, would be easy to write and easy to give, and it would certainly save a lot of grief.

I know of one engineering professor who makes effective use of this method. The first time his engineering mathematics classes are assembled, they are given an examination covering practical problems in the fundamentals. If they pass this examination, they are qualified to go ahead with the course. If not, they lack grounding, and they are immediately discontinued from the course and given a chance to start a review course.

This is a help to the student, not a hindrance. If he had been allowed to continue, he would surely fail in the course and be worse off than if he had taken nothing. Going back and reviewing strengthens his grasp on the fundamentals, and the benefits are permanent. The result of this preliminary weeding-out process is that there are few failures, even though the course is an extremely difficult one.

On every hand you see engineers who are "slow at figures." Adding a column of figures, performing a simple multiplication, or finding the volume of a pipe —these become tedious operations to them. They have to reach for a pencil and a pad to get the answer to "$8.60 plus 5 per cent." And some of them are engineering course graduates.

These are usually the same engineers who are unable to write a clear, concise report to their superiors, or else they are unable to write the report in such a manner that the non-technical superior is able to get some meaning out of it.

Mr. Davis urges telling every high-school senior what things will be useful to an engineer. That is good as far as it goes, but there are some of the useful things that should have been impressed on his mind before he reached the fourth grade. That would impress him with the importance of giving more attention to the three R's and less, later on, to such subjects as Greek history.

W. J. RISLEY, JR.

North Glenside, Pa.

Why Cannot the Power Factor Be Adjusted?

Referring to the question of T. E. Lorain in the July 7 issue, "Why Cannot the Power Factor Be Adjusted?" the question as outlined, is neither clear enough nor detailed enough to enable one to give a complete and definite reply. Since no details are given of the electrical interconnections between the plants, any remarks will have to be made on certain assumptions, which may or may not be correct.

It seems evident that whatever may be the actual conditions, a voltage of 2,500 maintained at all times on the bus, of what I understand as plant B, is too high for the particular generating equipment there installed, or in other words, reducing the field currents at the plant B to raise the power factor of the station would produce an unstable condition, which might tend to cause the generators to fall out of step, set up a hunting condition or even motorize, due to the changes set up in line conditions.

It is not quite clear to me what is meant by the statement, "Taps on the transformer at the hydro-plant B are set to give neither boost nor voltage drop." Assuming that there are step-up transformers at both

plants *A* and *B* and the two plants are connected by a transmission line, the statement on this basis would seem to be ambiguous. It seems more so if the load requiring a bus voltage "around 2,500 volts" is the bus at plant *B*. Obviously, a more complete description of the system with a diagram showing the actual connections would be of material assistance in giving a correct and intelligent reply.

It has occurred to me that an experience I had some time ago of a somewhat similar nature may be of interest. A certain gas-engine plant had a generator that could give a maximum of only 2,200 volts. Additional load was taken on and certain feeders added which required a higher bus voltage; in addition this station, which had previously been operating as an isolated one, was connected through transformers to another system which was supplied from a hydro plant and a steam-turbine plant. It was found necessary, with the added load and increased length of certain feeders, to raise the bus voltage to 2,400 or about 10 per cent above that previously existing. A condition therefore arose similar to the one described and the power factor of the gas-engine plant became one of serious moment when in operation.

Two solutions were possible—one to equip each feeder with an automatic voltage regulator, which would have permitted the bus voltage to be kept as before, the other to put a boosting transformer directly in the generator circuit to give a permanent boost to the generator voltage. Since, in this particular case, both expense and time had to be considered, the latter method was adopted, particularly as a suitable transformer was immediately available and either a 5 or 10 per cent boost could be given by reconnecting. No difficulty was experienced in keeping the power factor of the generator between 80 and 90 per cent when in operation.

Springdale, Pa. C. OTTO VON DANNENBERG.

Loss of Boiler Tubes at High Ratings

The interesting article by Paul F. Hoots in the June 9 issue of *Power* on the tube losses on oil-fired boilers in the Market Street Station of the New Orleans Public Service, Inc., has prompted me, as an engineer of twenty years' power-plant experience, to explain some tube trouble encountered in a plant where underfeed stokers and coal were used, and also when this plant was changed over to oil burning.

The boiler plant consists of ten horizontal water-tube boilers: Four 6,094-sq.ft. boilers installed in 1916, two of the same size installed in 1918, and four 6,826-sq.ft. units installed in 1921.

The first six boilers were equipped with underfeed stokers, and during the year 1920 the load had so outgrown the boiler plant that the boilers were operated at 25 per cent of rating for ten to eleven hours a day and 5½ days a week. The average rate of boiler feed was around 260,000 lb. an hour.

Owing to the amount of steam used for manufacturing purposes, practically 70 per cent of the total boiler feed is made up of raw water which passes through an open feed-water heater along with the 30 per cent available condensation returned to the boiler room.

The raw water is taken from a pond and passed through sand filter beds before entering the feed-water heater, but owing to the condition of the river water supplying this pond, the feed water is not chemically or otherwise treated in the power plant. There is considerable chloride in the water and this causes foaming in five or six days after washing out, owing to concentration of the chloride.

During a week of careful study and analyses of the feed water it was found, that after washing out eight of the boilers on Sunday and taking samples from the steam and water drums at the same time each day, as shown by the accompanying table, the chloride content increased considerably each day until 400 parts per million was reached, then the boilers would foam and often prime. This feed water is overtreated to such an extent that after heavy rains, if the boilers are not washed out regularly, there is considerable trouble experienced with foaming. The scale that forms in the boilers is of a soft spongy or porous nature, the tubes nearest the steam drums and farthest away from the furnace having the hardest and heaviest deposits.

During the time from 1916 to 1920, owing to overload conditions and to brickwork and stoker repairs, there was little time left for the proper and necessary turbining of tubes and regular boiler cleaning; as all repairs, cleaning, etc., had to be done between 6 p.m. Saturday and Monday morning, as the six boilers had to be on the line for 200 per cent rating at 7 a.m. During these four years there were only five tubes replaced in the six boilers, as follows: No. 4 boiler, one tube in the bottom row on Dec. 8, 1918; No. 4, one tube, July 10, 1919; No. 2, two tubes on July 25, 1920; No. 5, one tube July 25, 1920. From this record it will be noted that the first tube was two years old, the second three years, the next two four years and the last one two years.

In 1921 the four new boilers were installed and put in operation using fuel oil, each boiler being equipped with four mechanical burners capable of operating the boilers at 25 per cent rating. As soon as these units were put in operation, the stokers were removed from the older boilers, two at a time. Then, the furnaces were remodeled and each boiler equipped with oil burners. The boiler load at this time (due to more additions and increased production in the manufacturing plant) increased to 360,000 lb. of steam per hour and on peak loads to 400,000 lb. per hour. Of this amount of boiler feed, from 70 to 80 per cent was raw makeup water from the same source as in the past years. The last of the furnaces to be remodeled and equipped with oil burners was No. 1, which was put in operation in June, 1922.

As previously mentioned the plant peak load is from 7 a.m. to 6 p.m., after which the load falls off to an average of 60,000 lb. of steam per hour. When the stokers were in operation, it had been customary to bank four fires in the evening and run two boilers through the night, using two different ones each night; but having all the boilers oil-fired, the burners would be shut off all except two, and these two would carry the night load.

During the latter part of 1923 considerable trouble was experienced with the brickwork in the furnaces, due to considerable expansion and contraction, and to overcome this, it was decided to try to keep the furnace temperature as high as possible during the low night load. So instead of running only two boilers, there was one burner left under each boiler during the night, but this proved to be too much fuel for the load during certain hours, and necessitated cutting down the burners to a rating much below what they had been designed for. This caused considerable dribbling at the tips and spattering of unatomized oil on the tubes; also

carbon would form on the burner tips and cause a deflecting of the flame and a blowtorch action on the tubes. This method of operation at night was started on Oct. 5, 1923, and our troubles with tubes began about two months later. After looking into our records, methods of operation, and careful examination of the old tubes, it was decided that the cause of the bagged tubes was external and not from scale on the inside as our maximum rating was 200 per cent and our boilers had not been pushed as hard as the other ones had been under stoker operation. The first of tube renewals was made on No. 7 boiler on Dec. 13, 1923, which was one of the four new boilers and had been in operation for only two years.

The photographs of the bagged tubes, shown on page 900 of the June 9 issue, is a good illustration of the bags on these tubes, and also the thinning out of the metal through the center of the bag. These tubes would bag down until the metal was so thin that a small crack about ⅛ in. in length would appear and just sizzle and drip under 200 lb. pressure, but at no time has a boiler been shut down immediately due to tube leakage.

On Dec. 17, 1923, the boilers were again operated on the original schedule, regardless of the renewal of brickwork, until the proper burner tips could be procured to run one or two burners at their maximum capacity under every boiler to carry the night load, and this meant that the boilers would be carrying only from 25 to 50 per cent of their rated capacity. Of course, the damage to tubes had been done; every boiler showed signs of bagged tubes in the bottom row. These have been carefully watched, and eight of the ten furnaces are inspected every Sunday and the tube conditions recorded for reference, and renewals made as becomes necessary.

On Jan. 4, 1924, the smaller tips were put on burners under each boiler for the night load, and from that date up to the present time the renewal of tubes has been materially reduced. During the first six months of this year there have been only two tube renewals as against thirty-four during the first six months of 1924. During October, November and December of 1923 forty-two tubes were renewed, and during the same period in 1924 only six tubes were renewed.

Our records show that Nos. 3, 6 and 9 tubes in the bottom row of No. 5 boiler were renewed on Nov. 28, 1923, and again in September, 1924; also on No. 4 boiler No. 17 tube was renewed on July 9, 1924, and again on Sept. 15, 1924; this tube lasted only ten weeks.

Again on No. 5 boiler, No. 18 tube, which was renewed on Dec. 17, 1923, was found to be bagged after only six days' run, and this tube has never leaked although bagged and is in service up to the present time. A record has been kept on this tube every Sunday since the original bag showed up. Conditions today, as far as load, operation, repairs, maintenance, etc., are concerned, are the same as they were during the first nine months of 1923; the only change has been the use of burner tips with a small outlet on the night load. Under the present operating conditions furnace repairs have been reduced to a minimum.

During the period of greatest tube losses considerable experience was gained in trying to locate the cause of the trouble and a remedy for it; the color of the tubes in the furnace was watched from Sunday to Sunday during the weekly inspection of the furnaces and tubes on eight of the boilers. In one boiler two tubes side by side were watched carefully; both showed heavy carbon deposits on the outside. These two tubes were designated *A* and *B* for reference. The oil-carbon deposit was removed from the outside of tube *A* and left on tube *B*. Then tube *B* was turbined internally to make sure there were no deposits of scale. The following Sunday these two tubes were again inspected and the same thing done as before, but it was noticed that tube *B* was bagging slightly. On the third Sunday it was found that one of the bags on tube *B* was leaking and this tube had to be renewed, while tube *A* is in the boiler up to the present time.

Referring to the article in the June 9 issue, the makeup water for the plant referred to is only 5 per cent of the total feed, and this 5 per cent is produced by evaporators, and yet even with distilled water for makeup, there are considerable tube losses, which presumably for a while anyway (by the addition of three pounds of soda ash to ten million pounds of feed water per day) has been reduced or stopped. Whereas, at the plant referred to in the present article, using 70 to 80 per cent raw makeup water, when an occasion arose on tube losses, the trouble has been overcome by the proper operating of the fuel-oil burners, and the feed water left alone.

TOTAL ALKALINITY IN BOILER WATER CALCULATED AS PARTS Na_2O PER MILLION PARTS OF WATER

Boiler No.	Mon.	Tues.	Wed.	Thurs.	Fri.	Sat.
3	..	19	33	39	65	89
5	12	78	90	165	176 [512]	162 [478]
6	22	67	50	119	123	142
7	16	42	87	100	124	174
8	16	45	85	115	133	155 [422]
9	25	79	69	127	145 [416]	150 [448]
10	22	47	69	104	134 [365]	153 [448]

Figures in brackets denote p.p.m. of chloride, calculated as Cl. Boilers No. 5, 8, 9 primed on Friday at noon. Boiler No. 10 primed Saturday morning.

It will be of considerable interest to watch the record of these two plants over a certain period and note which will lose the greater number of tubes and whether one will eventually have to look into the furnace operation for trouble or the other plant have to look into the feed-water conditions for the cause of its tube losses.

On close examination of the bagged tubes it was found that the bags had a hard brittle deposit on the outside, which could easily be chipped off, while the wall of the tube at this point had become thin and showed that oxidation of the metal had taken place on the outside. If these tubes had been overheated while dry and bagged from the pressure, there would be a large crack in the bag the instant the water touched it after the scale broke away, and there would be no breaking down of the physical or chemical structure of the metal, which has appeared on every one of these bagged tubes. It would hardly seem possible for enough moisture to be present in the furnace at 2,750 deg. F. and 17 per cent excess air going to the mechanical atomizer to form enough magnetic oxide of iron on the outside of the tube and so decompose the metal down to the thickness found at the bag. Today, in some of the six older boilers there are tubes that have been in daily operation since the boilers were installed, that have no bags on them whatsoever, and on each side of these will be found new tubes that bagged after one to two weeks' operation after installation, during the period from October, 1923, to December, 1923. Further discussion of this subject might prove of value.

Fall River, Mass. W. H. BURTON,
Chief Power Plant Engineer,
American Printing Co.

Questions and Answers

Conducted by

Franklin Van Winkle

Unequal Bearings of Boiler Lugs

If a return-tubular boiler has three lugs on each side for direct wall bearings, which of these carry the most load? *W. P. S.*

The setting naturally adjusts itself to three principal points of support. A short time after the boiler is put in use, the weight will be carried mainly by two lugs on one side and one lug on the other side of the boiler. When two of the lugs take bearing at one end of the boiler, the greatest load will be carried by one of the lugs at the other end or still more will be carried by one of the central lugs. If both central lugs take bearings with one of the end lugs, then the main load is carried by the central lugs and the greater load comes on that central lug which is on the side of the boiler which has no other bearing.

Utilization of Oversize Boiler for Steam Heating

For summer use we will require a fire-tube boiler having about 600 sq.ft. of heating surface. Could the same boiler be used economically during the winter season for heating the building when 4,000 sq.ft. of radiation is to be supplied with steam? *P. B. M.*

A boiler having 600 sq.ft. of heating surface would be about 25 per cent larger than necessary for 4,000 sq.ft. of radiator and pipe surface required for heating the rooms of a building. But by covering with firebrick about 25 per cent of the grate ordinarily allowed for the boiler of 600 sq.ft. of heating surface, it should supply steam for 4,000 sq.ft. of radiating surface quite as economically as a boiler of size ordinarily used for that amount of radiating surface. The objection to the use of a boiler larger than necessary is that, in requiring less frequent attendance the firing and cleaning of the fire are not likely to be performed as thoroughly as when a small fire is depended upon. The remedy is to reduce the size of grate to the requirements of thoroughly cleaning the fire at least once every 24 hours.

Adjusting Crosshead Shoes

Where would an engine be placed to take up wear on the crosshead shoes? *C. H.*

Adjustment of the shoes should be adopted to the piston rod. When the engine turns over, the lower crosshead shoe takes the pressures on the guide and the lower shoe should be adjusted to relieve any downward pressure of the piston rod in its stuffing box, especially when the engine stands on the head-end dead center and the upper shoes should follow the adjustment of the lower shoe, leaving only enough clearance for good lubrication throughout the whole stroke. When the engine runs under, the principal wear and pressure comes on the upper guide, but the crosshead should be raised by adjustment of the lower shoe to such adjustment of the upper shoe that the piston rod will not be pressed upward in its stuffing box when the crosshead is raised to obtain a firm bearing of the upper shoe on the guide, especially when the engine is on the head-end dead center. Then the lower guide should be slackened only enough to obtain the proper clearance for lubrication of the upper guide.

Air Trouble with Centrifugal Pump

We are troubled with formation of air pockets in a centrifugal pump which is supplied with water delivered under 10 ft. head to the suction line approximately 1,000 ft. long. How can the pump trouble be remedied? *W. B. K.*

Undoubtedly, most of the air is delivered with the suction water. No matter what the rate of flow, some of the head at the source of supply is used up in overcoming pipe friction. For instance, with a 6-in. line 1,000 ft. long delivering the water at the rate of 325 gal. per min., the loss of head from friction would be equal to the total head, resulting in gradual reduction of the pressure and liberation of air all along the suction line. The air thus liberated, as well as the water, must be handled by the pump. Automatic air relief valves, which usually are float-operated valves, like a feed-water regulator used on house-heating boilers, are sometimes employed on large mains at places where they are enlarged at intervals for gathering air, or "hand-operated" blowoffs may be placed at high points in the line. A simple method would be to have the suction water delivered by gravity to an open cistern near the pump so the liberated air could be separated before the water if picked up by the pump suction.

Output of Steam-Heated Evaporator

How many pounds of steam at 20 lb. gage would be generated in an evaporator 5 ft. 6 in. in diameter and 7 ft. high from water at 160 deg. F. containing a condenser drum having 408 two-inch copper tubes for circulation of water inside and steam at 50 lb. gage outside of the tubes, and how many pounds of the steam at 50 lb. gage must be supplied per hour, the condensate to be drained off as rapidly as formed? *W. F. T.*

The rate of heat transmission through copper tubing from steam to boiling water depends on the condition of the tube-heating surface and the activity of circulation of the water over the tube surface, and may vary from 380 to 100 or less B.t.u. per square foot per hour, per degree difference between the temperature of the steam and that of the water. The value assumed for a coefficient not based on actual trial of the apparatus must be regarded as only approximate. For practical purposes the figure may be assumed to be 100 B.t.u.

The temperature of the water with evaporation at the pressure of 20 lb. gage, or 35 lb. per sq.in. absolute, is 259.3 deg. F. and the heat of the liquid is 227.9 B.t.u. per lb. To raise each pound of water from 160 deg. F. to the temperature of boiling would require 227.9 — (160 — 32) = roundly 100 B.t.u. The average temperature would be (259.3 + 160) ÷ 2 = 209.6 deg. F.

The temperature of the steam supplied at 50 lb. gage would be 298 deg. F. and allowing 100 as the coefficient of heat transfer, each pound of water raised per hour to the temperature of the boiling point (259.3 deg. F.) would require 100 ÷ (100 × (298 — 209.6)) = 0.0113 sq.ft. of pipe surface. The latent heat of evaporation at the pressure 20 lb. gage, or 35 lb. per sq.in. absolute, is 938.9 B.t.u. per lb., and for adding the latent heat after the water has attained the temperature 259.3 deg. F. would require 938.9 ÷ (100 × (298 — 259.3)) = 0.2426 sq.ft., or for evaporation from feed water at 160 deg. F. each pound would require 0.0113 + 0.2426 = about 0.2539 sq.ft.

The heating surface of the tubes would be 408 × (2 × 3.1416) × 3.5 ÷ 12 = 747.7 sq.ft., and for the assumed coefficient of 100 there would be 747.7 ÷ 0.2539 = 2,945 lb. of water evaporated per hour.

Each pound of the water for its evaporation into steam would require (227.9 + 938.9) — (160 — 32) = 1,038.8 B.t.u. The steam supplied at 50 lb. gage would part with its latent heat of evaporation, namely 911 B.t.u. per lb., and regardless of the rate of transfer of heat each pound of water evaporated would require 1,038.8 ÷ 911 = 1.14 lb. of steam to be supplied at the pressure of 50 lb. gage, with discharge of the condensate at the temperature of 298 deg. F. This is in addition to the steam required to compensate radiation.

Effect of Loose Rivet on Strength of Double Strap Joint, Double Riveted

How would the efficiency of a triple-riveted butt and double-strap joint be affected by a loose rivet in the second row, where the tensile strength of plate is 55,000 lb. per sq.in.; thickness of plate, ½ in.; thickness of butt straps, 7/16 in.; pitch of rivets in outer rows, 7¾ in.; and diameter of rivet holes, ⅞ in.? F. C.

Having tensile strength of plate = 55,000 lb.; thickness of plate ½ = 0.5 in., thickness of butt straps 7/16 = 0.4375 in., pitch of rivet in the outer row 7¾ = 7.75 in. and twice the pitch of rivet in the second and inner rows, diameter of rivet holes ⅞ = 0.875 in., giving cross-sectional area of rivets that completely fills the holes = $(0.875)^2 \times 0.7854 = 0.6013$ sq.in., and assuming the strength of a rivet in single shear = 44,000 lb. per sq.in. and in double shear = 88,000 lb. per sq.in., and also assuming the crushing strength of plate = 95,000 lb. per sq.in., then for a length of the joint equal to a unit of pitch, indicated by the dimension *P* in the sketch, with all rivets completely filling the holes:

(1) Strength of solid plate = 7.75 × 0.5 × 55,000 = 213,125 lb.

(2) Strength of plate between rivet holes in an outer row = (7.75 — 0.875) 0.5 × 55,000 = 189,063 lb.

(3) Shearing strength of four rivets in double shear, plus the shearing strength of one rivet in single shear = ((4 × 88,000) × 0.6013) + (1 × 44,000 × 0.6013) = 238,115 lb.

(4) Strength of plate between holes in the second row, plus the shearing strength of one rivet in single shear in the outer row =

(7.75 — (2 × 0.875)) 0.5 × 55,000) + (1 × 44,000 × 0.6013) = 191,457 lb.

(5) Strength of plate between rivet holes in the second row, plus the crushing strength of inside butt strap in front of one rivet in the outer row =

(7.75 — (2 × 0.875)) 0.5 × 55,000) + (1 × 0.875 × 0.4375 × 95,000) = 201,367 lb.

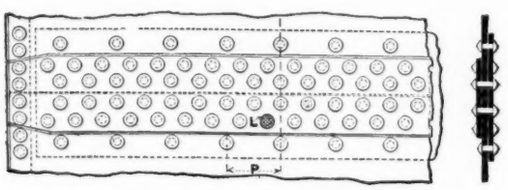
(6) Crushing strength of plate in front of four rivets, plus the crushing strength of inside butt strap in front of one rivet =

(4 × 0.875 × 0.5 × 95,000) + (1 × 0.875 × 0.4375 × 95,000) = 202,617 lb.

(7) Crushing strength of plate in front of four rivets, plus the shearing strength of one rivet in single shear =

(4 × 0.875 × 0.5 × 95,000) + (1 × 44,000 × 0.6013) = 192,797 lb.

The least strength for a unit length of joint *P* for a perfect joint is derived from consideration (2),



Loose rivet L in triple-riveted butt and double strap joint

namely 189,063, and as according to (1), the strength of the solid plate for the same unit length of joint would be 213,125, the efficiency of a perfect joint would be 189,063 ÷ 213,125 = 0.887 or 88 7/10 per cent.

If there is a loose rivet *L* in one of the second rows, there would be three instead of four rivets in double shear in the pitch *P* and in place of 238,115 lb. for consideration (3) the strength would be

(3*a*) 238,115 — (1 × 0.6013 × 88,000) = 185,201 lb.

Also, in place of 202,617 lb. for consideration (6) with crushing strength of plate in front of four rivets in the inner and second rows there would be crushing resistance of plate in front of only three rivets in the inner and second rows and the strength would be

(6*a*) 202,617 — (1 × 0.875 × 0.5 × 95,000) = 161,054 lb.

Also in place of 192,707 lb. for consideration (7) with crushing strength of plate in front of four (4) there would be only three such rivets and the strength would be

(7*a*) 192,707 — (1 × 0.875 × 0.5 × 95,000) = 151,145 lb.

Hence with a loose rivet *L*, the least strength for pitch *P* would be derived from consideration (7*a*), namely 151,145 lb., and the efficiency of the joint, referred to the pitch *P*, would be 151,145 ÷ 213,125 = 0.71, or 71 per cent; that is, with a loose rivet *L*, the strength would be reduced (0.887 — 0.71) × 100 ÷ 0.887 = 20 per cent.

[Correspondents sending us inquiries, should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communication and for the inquiries to receive attention.—Editor.]

A new slant on things observed in and out of the power plant

What Happens and Why?

How Much Difference Does the Vacuum Make

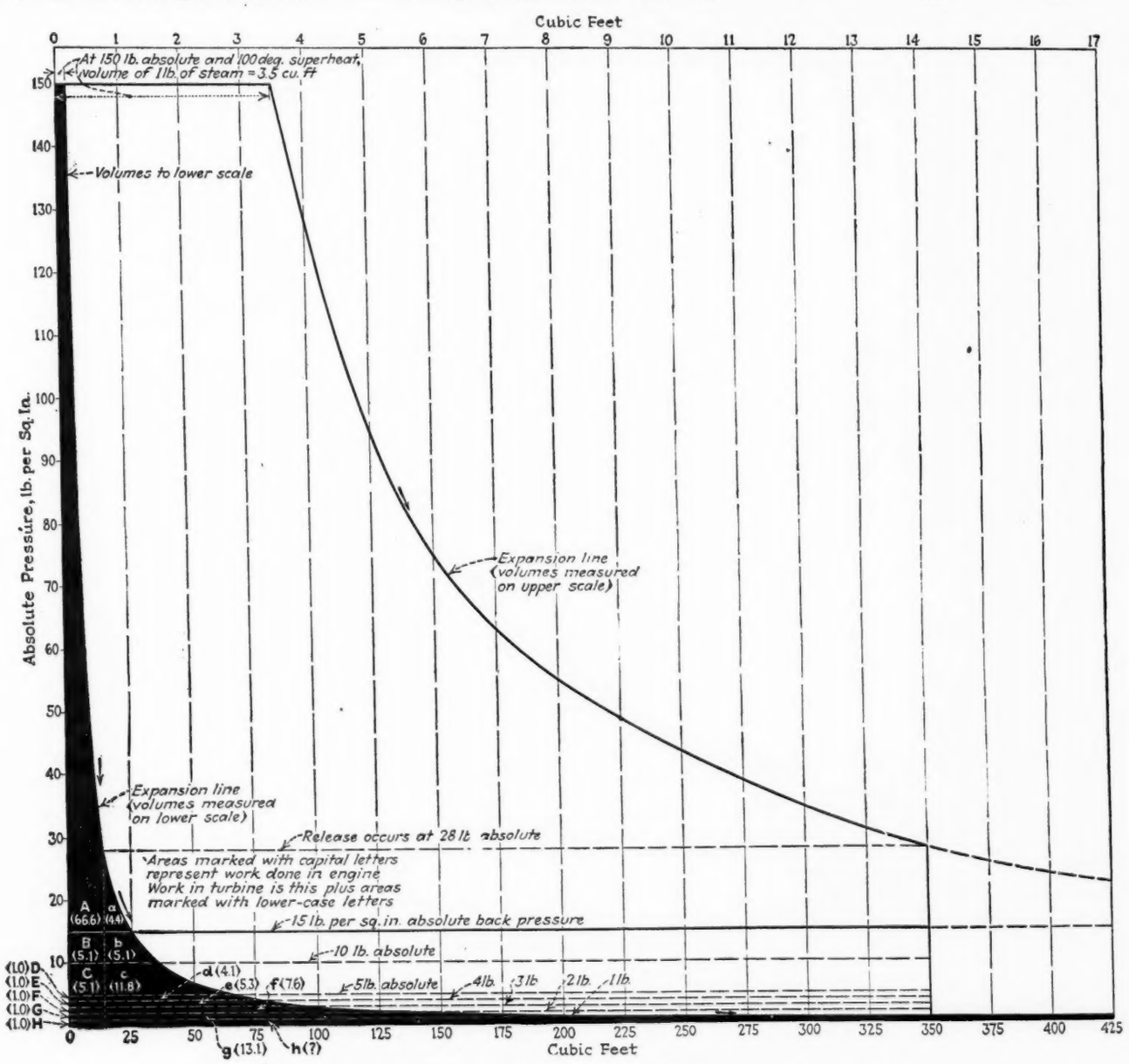
WHY is high vacuum so much more important with steam turbines than with reciprocating engines? The accompanying diagram will make the reason clear. The curve bounding the portion in solid black represents the adiabatic or theoretical expansion of one pound of steam from an initial condition of 150 lb. absolute pressure and 100 deg. superheat.

Assuming release at 28 lb. absolute, *A* (shown also to larger scale) becomes the indicator diagram for an idealized steam engine exhausting at atmospheric pressure. The figure in each area is proportional to the area and represents the horsepower theoretically available from 1,000 lb. of steam per hour. With atmospheric back pressure the engine would deliver $A = 66.6$ hp. and the turbine the additional $a = 4.4$ hp., or a total of 71.0 hp.

Now note how the gain from reduced back pressure is constant for the engine, but increases rapidly for the turbine. The first 5 lb. of vacuum adds 5.1 hp. to the engine and 5.1 + 5.1 = 10.2 hp. to the turbine. The next 5 lb. adds another 5.1 hp. to the engine, but 5.1 + 11.8 = 16.9 hp. to the turbine. A summary of the results is given in the table. Note that a reduction of back pressure from 2 lb. to 1 lb. benefits the turbine 14 times as much as it does the engine.

POWER THEORETICALLY AVAILABLE FROM 1,000 LB. OF STEAM PER HOUR

Back Pressure, Lb. Absolute	Power From Engine	Power From Turbine
15	66.6	71.0
10	71.7	81.2
5	76.8	98.1
4	77.8	103.2
3	78.8	109.5
2	79.8	118.1
1	80.8	132.2



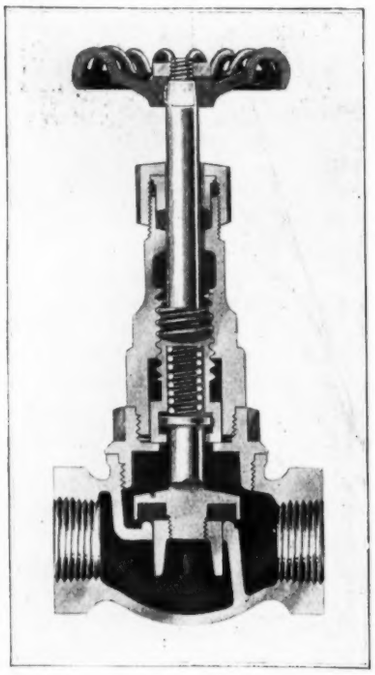
Areas marked by lower case letters indicate additional power from turbine

New and Improved Equipment

Ohio Self-Seat Valve

A type of valve in which the seat and disk are always brought into contact and held together by the same pressure has been brought out recently by the Ohio Injector Co., Wadsworth, Ohio.

Referring to the illustration, which shows a section of the valve, it will be seen that the stem is enlarged at the lower end and bored out to receive a



Section of self-seat valve

tension spring and short extension on the top of the disk. Sufficient freedom is provided in the slot, in the end of the stem, to permit the disk to be seated by the spring and to prevent any pressure being exerted on it by the stem.

The disk is fitted with guiding wings on the lower side and also carries a composition ring which is held in place by the winged collar threaded to the bottom of the disk body.

Fitchburg Unaflow Engine

The Fitchburg Steam Engine Co., Fitchburg, Mass., has entered the unaflow engine field with a design embracing several unusual features. The frame follows the general lines of the Fitchburg counterflow piston-valve engine and consequently the cylinder and valve gear only will be discussed.

As with all unaflow engines steam is admitted at the ends of the cylinder and exhausted through a row of center ports. The steam valves are of the hollow piston type and are provided with snap rings. Each is housed in its own cage or steam chest, being connected by a valve stem and are actuated by a shaft-governed eccentric.

As shown in Fig. 2 steam enters through an opening in the top of the cylinder and passes down and around the valve housing. At the proper time the movement of the piston valve uncovers the steam ports and the steam passes across the valve edge as well as through slots in the valve body. In effect a double-ported entrance is obtained. In Fig. 2, while the arrow indicates the steam path, the ports are covered by the valve, the position of valve and piston being that after cutoff has occurred.

The arrangement of steam passages is such that the cylinder heads are steam-jacketed, thus realizing the original unaflow principle of hot cylinder ends and a cold exhaust belt.

To obtain maximum efficiency, the clearance of a unaflow engine must be made as small as possible. On the other hand, when the clearance is small, the compression pressure rises to an abnormal value. To avoid this, part of the steam trapped in the cylinder by the piston covering the exhaust ports is allowed to pass out of the cylinder through other channels. In the Fitchburg engine auxiliary exhaust valves are provided by which exit from the cylinder is not closed until the piston has completed part of its return or compression stroke. These piston

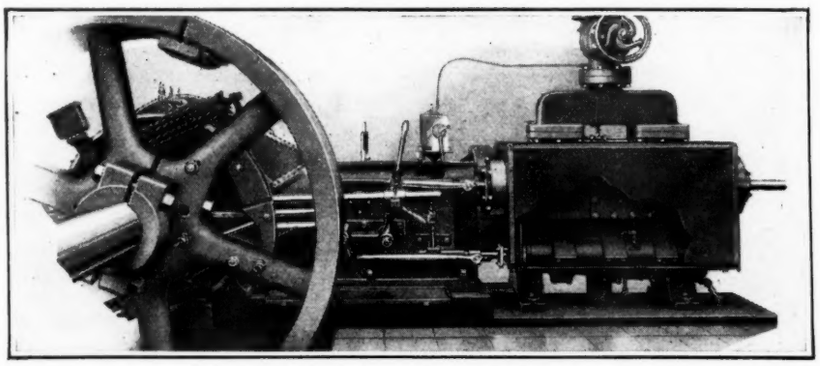


Fig. 1—Fitchburg Unaflow Engine

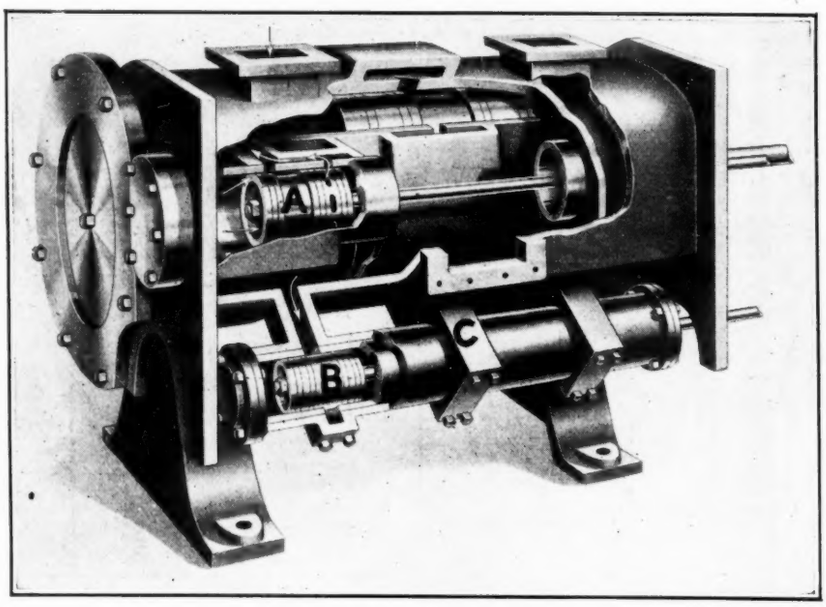


Fig. 2—Sectional View of Fitchburg Cylinder

valves are placed in removable bushings which are supported by a cast-iron housing. This housing is bolted to the cylinder casting and contains ports leading from the cylinder and an outlet passage connecting with the main exhaust-port belt. The two auxiliary exhaust valves are driven by an eccentric on the crankshaft.

One advantage promised by the design is the adaptability of the cylinder to existing engines. Only minor alterations to the eccentric, rocker arms, etc., are necessary when attaching the unaflow cylinder to an old counterflow engine frame.

Kirkaldy Electrolytic System of Protection for Boilers and Condensers

The electrolytic system of preventing corrosion and scale formation in boilers and condensers has been quite extensively used in the marine service. Recent developments along this line, made by the Kirkaldy Engineering Corp., 52 Vanderbilt Ave., New York City, have brought out a system especially adapted to stationary-plant practice.

The system embodies the principle of maintaining a constant supply of electricity at low voltage to a number of anodes placed at suitable locations in the boiler, condenser or other vessel to be protected, the boiler surface, condenser tubes, etc., forming the cathode of the circuit. At the anode or anodes, due to electrochemical action, combinations take place between the iron of the anodes and the oxygen or acid radical of the impurities in the boiler or condenser circulating water. In this way the anodes eliminate the constituents of the water that would otherwise cause destructive corrosion of the boiler shell or boiler tubes.

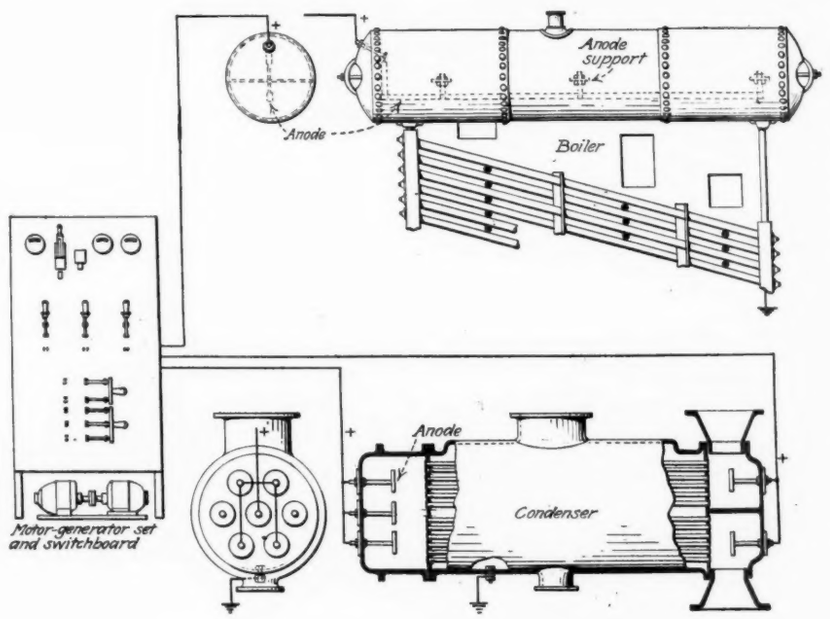
The general arrangement of the anodes in a boiler and condenser is shown in the illustration. In a horizontal water-tube boiler the anodes are suspended below the water line as shown in the upper view. In a surface condenser they are arranged at suitable points in the circulating water passes at each end of the condenser as shown in the lower view.

The electrode for boilers is constructed with a distance piece of metal and is insulated from the boiler shell and current bar with a minimum of exposed insulation within the boiler. The electrode for condensers has the conductor and its insulation completely incased within a metal tube forming a single unit. The metal casing of the conductor is threaded for a considerable length on the outer end to afford means of adjusting the anode within the condenser, to change the position of it with relation to the part to be protected.

For supplying the current to the anodes a motor-driven direct-current generator set and complete control board is provided as illustrated at the left of illustration. The amount of current supplied to any particular boiler or condenser is varied and controlled by adjustable resistances.

As it is essential that no reversal of current or polarity of the poles of the circuit take place while the system is in operation, a reverse-current relay is inserted in the main circuit to open it automatically should the direction of the current be accidentally reversed.

The system, in addition to protecting the boiler or other vessels from corrosion, is claimed to prevent the formation of hard adherent scale. This protection is brought about by the film of hydrogen produced electrolytically over the surface of the boiler or condenser tube, thereby preventing the adhesion of scale and other impurities to these surfaces.



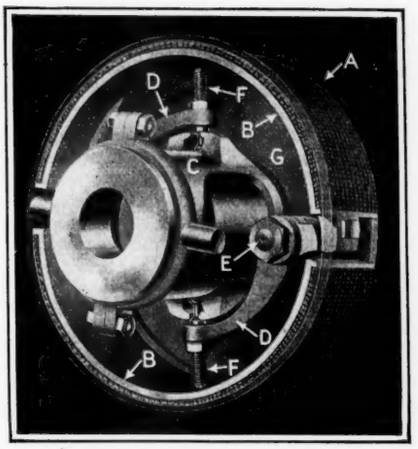
Arrangement of anodes in boiler and condenser

Hoerl Friction Clutch

The illustration shows a type of friction clutch recently brought out by the Wolf Co., Chambersburg, Pa.

Contact with the driving shell *A* which carries a long hub and is keyed to the shaft, is made by means of two half-rings *B*, which are lined on the outer surface with Raybestos. These rings are pushed against the shell by the action of the cone *C*, which forces the ends of the arms *D* outward. The arms are hinged on studs *E* carried in the plate *G* which is keyed to the other shaft. The design of the friction rings *B* and the method of pressing them against the shell tends to give a uniform bearing on the clutch surface.

As the heads of the adjusting screws *F* are carried in slots in the cone *C*, they draw the rings away from the shell when the clutch is thrown out, thus assuring a positive release. Adjustment of the clutch is made by means of the screws *F*.



View of clutch assembly

Extra Sensitive CO Recorder

In the *Engineering News-Record* for Sept. 10, 1925, on page 423, Messrs. Fieldner, Katz and Meiter report the development at the Pittsburgh Experiment Station of the U. S. Bureau of Mines of an instrument for recording the CO content of air in a vehicular tunnel. Concentrations are expressed in parts per 10,000 by volume, and the recorder is sensitive to 1 or 2 parts per million. Full description and details will appear shortly in U. S. Bureau of Mines technical paper 355, entitled, "A Monoxide Recorder and Alarm," by S. H. Katz, D. A. Reynolds and J. J. Bloomfield.

Tennessee Projects—The East Tennessee Development Co. has applied to the Federal Power Commission for preliminary permit covering a project on the Tennessee, the Clinch and Powell Rivers, in Hamilton, Rhea, Meiggs, Roane, Blount, Knox, Anderson and Claiborne Counties, Tennessee. It is proposed to erect dams and power houses at eleven different sites, at which an aggregate of 444,500 kw. will be installed.

Power Station Heat Balance

Prime Movers Committee of N.E.L.A. Reports Continued Developments—Motor Drive of Auxiliaries Still in Favor—Bleeder Heating in from Two to Four Steps the Standard Practice—New Type of Bleeder Heater Developed—Rapid Introduction of Full-Voltage Starting for Alternating Current Motors

THE Prime Movers Committee of the N.E.L.A., whose reports have in the past been of such practical value, continues to maintain this high standard in the reports that are now issued serially from time to time. The latest one, dated August, 1925, deals with the subject of Power Station Heat Balance. Although there is much of interest in the accompanying manufacturers' statements, lack of space makes it necessary to limit the following abstract almost entirely to the remarks of the committee itself.

Source of Power for Auxiliaries

The principal development during the last year has been the general introduction of the auxiliary generator and the spinning house generator as means of guaranteeing the supply of power to electrically driven auxiliaries. Probably more large stations have installed the auxiliary generators.

There is a growing tendency to consider the main generator and step-up transformer as a unit to eliminate, as far as possible, switching at generator voltage.

By far the greater number of auxiliaries are driven by motors. A comparison of the advantages of motor versus steam-turbine drive indicates that in modern stations the advantage lies with the motor drive, except from the viewpoint of continuity of operation when there is trouble on the system. For this reason there is a tendency to isolate the auxiliaries for each unit.

Excitation

The spinning house generator (that is, a turbo-generator kept up to speed at no load for emergency use) has the advantage of not displacing the direct-connected exciter on the end of the shaft of the main unit. One plant has enlarged the direct-connected exciter in order to make an auxiliary generator of it, the capacity being 500 kw. for a 20,000-kw. unit. This exciter furnishes the excitation, and drives the circulating pump, condensate pump and boiler-feed pump.

Relay Protection

Trouble with motor-driven auxiliaries has frequently occurred from the use of improper relays. Some member companies have finally decided on the use of balanced relay protection as the only protection that is needed and the only one that will enable electrically driven auxiliaries to furnish a type of service comparable with that of steam-driven auxiliaries.

Duplicate Auxiliaries

Duplicate auxiliaries are installed in practically all cases. This is being carried so far that in many cases a type of condenser that is really a duplicate condenser is being installed.

Growing realization of the importance of fixed charges has led to the use of more auxiliary power in order to decrease the capital investment at the expense of a slight decrease in efficiency.

Ability To Start the Station

The committee is unanimous in the belief that some other source of power than that of the main unit should be provided for starting up a station in case of a complete shutdown. Too much dependence should not be placed on transmission lines leading to external sources of power.

Requirements for Reliable Electrical Service

The majority of the committee favors the use of motor-driven auxiliaries, and a study of the plants recently developed indicates that the reliability of the auxiliaries has been improved by the following items:

Providing a separate source of auxiliary power for each unit.

Providing new sources of power for the various types of auxiliaries.

Placing the essential auxiliaries on different sources of power supply from the non-essential auxiliaries.

Providing duplicate auxiliaries, or in some cases providing duplicate drives where the auxiliary itself may be, as in the case of the induced-draft fans, a very reliable piece of apparatus.

Having no electrical connection between the essential auxiliaries and the transmission system.

Simplifying the relay system so that motors are disconnected from service only in case of direct trouble to the motor or the lead to it.

Using full-voltage-starting motors on all essential auxiliaries.

Providing a house generator that is available for quick starting in case of a shutdown of the station or which automatically picks up at least the essential auxiliary load.

Automatically maintaining a constant voltage on the auxiliary or house generator.

Equipping house generators with satisfactory over- and under-speed devices to separate them from the main unit, in order to maintain the current supplied to auxiliaries at all times at normal frequency and voltage.

It is not to be expected that the committee would be unanimous in agreement as to the number of these items that should be included in any one plant. The effect, however, on the cost and efficiency of the plant of including all these items is small.

Feed-Water Heaters

The returns from a survey show that 53 per cent of the plants employ three-stage heating. Five out of eleven have economizers installed. In two of these plants the third-stage heater is located after the economizer. The average number of bleeder heaters used in the nineteen plants is 2.8. The average temperature leaving the last heater is 274 deg. F., and that entering the economizer 246 deg. The average temperature entering the boiler without economizer is 290 deg. and with economizer 325 deg.

No statement has been received from either member companies or manufacturers indicating serious trouble with heaters. One manufacturer states that heaters designed for more than atmospheric pressure are generally equipped with tubes bent in a "U," or with floating heads, whereas these precautions are not necessary for heaters designed for atmospheric pressure or less. No serious trouble from splitting of tubes has been reported. In general, in heaters working at atmospheric pressure or lower, the condensate is handled by means of "U" bends, whereas traps are necessary for heaters working at higher pressures.

Experience shows that in calculating the heating surfaces of both heaters and evaporators, practically no account need to be taken of superheat. Experience has also shown that, whereas, manufacturers, to be on the safe side, have usually allowed for a terminal temperature difference of about 5 deg., the actual difference is much less, running as low as ½ deg. in some cases.

Closed heaters generally seem to be vented either to a lower level heating or lower stage of the turbine, either arrangement apparently giving good results.

Manufacturers of large turbines report that even relatively small turbines are now being provided with at least one and frequently two points for bleeding, and that the larger turbines are usually provided with three and, in many cases, four points.

Jet-type Extraction Heater

A new type of heater has been developed, which it is understood, has not yet been installed in any plant. The heater is of the Venturi jet type, the velocity of the water being increased in order to lower the pressure below that of the steam extracted from the main unit. This will call for very high water velocity. Some form of check valve should be installed in the connection between the jet feed-water heater and the turbine to prevent water being drawn into the turbine in case the heater discharge is stopped in some manner. In order to provide for the installation of a deaërating heater in the plant, it might be advisable, with such an arrangement, to install two sets of heaters, one working on the discharge of the condensate pump and the second working on the discharge of the boiler-feed pump. There is one apparent complication in the operation of such heaters; a certain adjustment in the area of the nozzles must be made to meet variations of the load.[1]

Effect of Makeup on Plant Layout

A study of nineteen plants on which data have been secured since the 1923-1924 report indicates that evaporators

[1]Five pages of the report are given over to heat-balance diagrams for the following stations: Cahokia, Colfax, Weymouth, Richmond, Westport, Valmont (Colorado), Amsterdam (Adirondack Power & Light Corporation). Lack of space makes it impossible to reproduce or discuss these diagrams here. Some of them, however, have been described in *Power*.

were installed in 64 per cent of the 1,349,000-kw. total capacity. The percentage of makeup for which evaporator capacity was installed was from 1.1 to 3 per cent, the average being 2.4 per cent. Of these plants 65.5 per cent supply the evaporator with steam bled from the main unit, 14.5 per cent use auxiliary turbine exhaust and 20 per cent use live steam.

This investigation demonstrates that in the plants using evaporators, by far the greater number obtain the steam for the evaporators from the third-level bleed point, the average temperature being about 305 deg. F. and that it is absorbed in the evaporator condenser, placed between the second- and third-level heaters. The size of all the units was 20,000 kw. or larger, with the exception of one 10,000-kw. unit.

Effect of Oxygen Content on Feed Water System

During the last year a number of deaërators have been installed, both in plants equipped with low boilers and economizers, and in plants equipped with high boilers. Practically all the plants put into operation since the 1923-24 report locate the deaërator at a point in the condensate system where the vapor pressure is slightly above atmospheric.

The amount of steam necessary to deaërate the condensate properly is about 2 per cent of the condensate. In case duplex-driven units, spinning house generators, or any steam-driven boiler-feed pumps are installed, the exhaust steam from these units, when running, is usually discharged into the deaërator, which thus becomes a plant heater. The additional steam, if anything, improves the operation of the deaërator.

Experience with the deaërating hotwell has not been of sufficient duration to determine whether it will maintain at all times the degree of deaëration of which it is capable. For this reason a number of plants are installing deaërator heaters to remove whatever oxygen leaks in, especially through the pump glands.

The advantages of maintaining the condensate system under pressure at all times has been mentioned in previous reports. This is usually done by placing the third tank at an elevated location. Such a surge tank should be located where the flow is into or out of it and not through it. One of the manufacturers has developed a closed feed-water system which is claimed to prevent oxygen enrichment.

Generator Air Coolers

Generator Air-Coolers are being installed on a large percentage of generators in steam power plants of present-day construction. One manufacturer estimates that generators totaling 2,000,000 kw. capacity are now cooled by the closed system.

Motors for Auxiliary Drive

Since the presentation of the 1923-24 report, the principal change in the types of motors used has been in the general adoption of full voltage starting for alternating-current motors. These motors have been very successful. Where a limited power supply is available for a number of full-voltage-starting motors, which might all be started together, there is some advantage in using the double squirrel-cage type, as this makes a decided reduction in the starting current.

On the circulating pumps, some of the member companies are installing squirrel-cage motors having two windings.

Small Turbines[2]

Practically all manufacturers of small turbines now furnish steel casings for use with high-pressure and high-temperature steam, and practically all turbines except the smallest are being supported as close to the shaft as possible, in order to take care of the greater expansion that occurs with high-temperature steam.

Most manufacturers, who have not re-designed their standard line of machines in the last few years, are doing so at the present time.

Probably the most important feature in the last year has been the designing of more efficient small turbines. While some of the American manufacturers have made such designs, the principal data have been received from the European manufacturers. A very considerable reduction in steam consumption is claimed. The machines are of course bulkier and occupy more floor space and are probably more expensive.

It is understood that installation of such equipment is being considered in a plant designed for one of the large member companies, which claims that the heat requirement of the station when using these small turbines will be nearly as low as could be obtained with stage bleeding and motor-driven auxiliaries. While the development of these efficient turbines was quite recent, the indications are that the majority of the member companies do not consider that the increased efficiency of these units offsets the increased maintenance, space requirements and first cost.

Boiler-feed Pump

Most of the leading manufacturers are now prepared to offer pumps to operate at pressures ranging from 400 to 600 lb., and a few are prepared to furnish pumps capable of delivering against pressures of 1,200 lb. or more.

For heads about 300-lb. pressure there seems to be a decided tendency toward the use of single suction pumps, that depend mainly upon hydraulic balance and are equipped with volute cases without diffuser vanes. Single-stage turbine-driven pumps for pressures up to 600 lb. can now be furnished by two manufacturers.

Forced- and Induced-Draft Fans

During the year there has been no startling development in the way of design or improved efficiency with fans used for forced or induced drafts, but there has been considerable improvement in the established designs resulting in a greater reliability.

The matter of cinder and dust removal has received considerable attention, and one of the manufacturers is claiming the removal of as high as 90 per cent. of the solids carried by the gases.

There is also a tendency for the manufacturers to build more rugged fans. Motor-drive is becoming more popular. The tendency to double-motor the induced-draft fan seems to be increasing.

[2]Turbines for driving house generators are included under this heading as well as small turbines for driving auxiliaries, either direct or through gearing.

The power (watts) delivered by a direct-current generator is equal to the volts times amperes. In an alternating-current generator this is true only when the current is in step with the voltage, consequently the product of the volts and amperes, with respect to power, may mean anything from zero to the value of their product; therefore kilovolt-amperes (kv.-a.) has been adopted as a unit for rating alternating-current generators, synchronous motors, synchronous condensers and transformers. For a single-phase circuit the kv.-a. $= \frac{EI}{1000}$; in a balanced two-phase circuit, kv.-a. $= \frac{2EI}{1000}$; and on a balanced three-phase circuit kv.-a. $= \frac{1.732EI}{1000}$, where E equals the voltmeter reading and I equals the ammeter reading. The wattmeter will give the load in kilowatts and this divided by kilovolt-amperes gives the power factor.

In general, in any direct-current machine, the number of interpoles may be made either equal to or half of the number of main poles. The usual practice is to use as many interpoles as main poles when the number of pairs of main poles is odd. For example, in a six-pole machine six interpoles and in a two-pole machine two interpoles are used. There is, however, no reason why a six-pole machine with three interpoles or a two-pole machine with only one interpole will not operate as well as a four-pole machine with two interpoles, the last arrangement being a common type of construction. When the number of commutating poles is half the number of main poles, the commutating poles are all of the same polarity; that is, they are either all north or all south poles.

In connection with the financial difficulties of France mention is again made in the press of the Rhone power scheme, which provides for developing water power, canals and irrigation in the Rhone Valley, a project which, in being carried to the first stage of success, would require a capital of $60,000,000. Authorization for letting this enterprise to private capital was granted by the French Parliament in 1921 and the power of approval given the Finance Minister.

But three obstacles are in the path: First, the atttitude of the present French Parliament toward aliens getting the concession; second, the possibility of floating the loan or loans in the United States, and, third, the possible position of the United States Government in the event the promoters would seek even indirectly to tie the construction work into the Franco-American war debt settlement.

Newcomen Society Honors Famous Men

The Newcomen Society of England on Aug. 5 placed a memorial laurel chaplet on the grave of Thomas Newcomen. The chaplet was sent to the Mayor of Dartmouth and he, with appropriate ceremonies, placed the chaplet on the monument, which stands in the Town Gardens. The same society placed a wreath on the bust of James Watt at the Science Museum, South Kensington, on the anniversary of his death on Aug. 25.

New Large Hydro Plant on Ohio River Under Way

The Standard Gas & Electric Co. announced recently that with the issuance of a license by the Federal Power Commission of the Louisville Hydro-electric Co., one of the Standard's subsidiaries, the Ohio River is to be used in the development of power on a large scale. Work will be started at once on the first modern power development on the Ohio, to be known as the Ohio Falls development.

The plant is to be at Louisville, Ky., and will be one of the largest single hydro-electric plants in the country, exceeded only in installed capacity by six others, while the initial installed capacity will be 108,000 hp. in eight 13,500 hp. units, with provision for an ultimate capacity of 135,000 horsepower.

The production of power there will be made possible by the construction of a dam nearly two miles long by the Federal Government as part of its plan to establish a nine-foot stage of water for navigation of the river from Pittsburgh, Pa., to Cairo, Ill.

Between Rock Island and Kentucky Short a power house, 508 ft. long, will be built under the supervision of the Byllesby Engineering & Management Corp. at a cost estimated at $7,500,000. The dam to be built by the government will cost $3,250,000, the entire project thus to entail an expenditure of $19,750,000. The hydro company will pay the government an annual rental for the use of the water power. It is expected that a yearly average output of 357,000,000 kw.-hr. can be produced by the waterwheels operating under a maximum head of thirty-seven feet.

Power from the development, which is to be completed not later than early in 1929, will be distributed primarily in Louisville by the Louisville Gas & Electric Co., of which the hydro company is a subsidiary. Transmission lines will connect Ohio Falls with the Louisville's company's 123,500 hp. water-side steam plant. By 1929, however, it is expected that the electrical demands of Louisville and surrounding territory will have increased to a point where a large new steam plant will be necessary. Plans have accordingly been made for the erection of the steam plant with an ultimate capacity of 250,000 horsepower adjacent to the hydro-electric power house at Shippingsport.

N.A.S.E. Elects Officers for Coming Year

The National Association of Stationary Engineers at its recent meeting at St. Paul, Minn., which was reported in the September 8 issue, elected the following officers for the coming year: Garrett Burgess, president; John Quincy Adams, vice-president; Fred Raven, secretary; S. B. Forse, treasurer; Thomas Clark, conductor; C. A. Dobson, doorkeeper; H. R. Hilton, trustee for five years. The next convention is to be held at Atlantic City.

Garrett Burgess

Other officers elected, but omitted from our report in the Sept. 8 issue, page 387 were: James D. Taylor, secretary-treasurer of the life and accident department; F. N. Chapman, secretary of the National Exhibitors Association.

Shannon Power Scheme Contract Let

The contract for the Shannon power scheme of the Irish Free State which was mentioned briefly in *Power*, Sept. 16, 1924, has been signed and work will begin on it this month. The construction for the power station involves considerable difficult excavating and will take probably about three years to complete, according to *The Engineer*, London. Below Lough Derg, the level of the Shannon River must be raised, huge embankments must be built and a certain amount of solid rock must be removed below the power station for a tailrace. At present the intention is to build a large station outside Limerick and to distribute current over two main lines to Dublin and Cork. The contract, which was signed for £2,500,000, does not cover the cost of distribution, but relates to the creation of the new canal, the building of the river embankments and the construction of the power station at Ardnacrusha.

Consumers Slow in Stocking Hard-Coal Substitutes

Now that the opposing forces in the anthracite industry have dug in for what promises to be a long-drawn out struggle, officials and others in a position to serve the public in this crisis, are much concerned because of the failure of anthracite-consuming regions to stock up with substitutes. Despite the fact that every day is precious, the movement of substitutes is slow.

When it is considered that anthracite is consumed in the winter at the rate of 7,000,000 tons a week, it means that large tonnages of bituminous coal and coke even now should be moving and orders should be rolling in at a much faster rate than is reported.

The New England fuel committees should make a budget of the normal rate at which anthracite is delivered to consumers. If, for instance, that rate for Massachusetts is 100,000 tons a week, then the committee should see to it that 100,000 tons of substitutes move into cellars of that state each week.

There is still another major reason why buying of substitutes should begin now. If the anthracite belligerents were to see that as much as 2,000,000 tons of substitutes actually are going into the bins of consumers each week, with the consumers pledged to receive a similar amount as long as the anthracite mines are closed, it would do more to hasten the settlement of the strike than would all the suggestions for arbitration or threats of investigation by Congressional committees. If consumers will exert the power they have at their command, the parties to this strike, it is declared, could no more stand against it than they could resist the progress of a glacier.

It is suggested that the local fuel commitees can help the situation materially if they will urge producers and dealers in substitutes to co-operate so that full-time fuel experts are provided in each community to go from house to house where substitutes are to be used to demonstrate how they should be burned. The committees also should arrange to have a consulting service to which the consumer could apply for advice as to the form of substitute best adapted for use in his furnace.

Engineer Grant of "Mackinac" Loses License

The examining board of the United States Steamboat Inspection Service, after hearing testimony,, has found Chief Engineer Grant of the steamer "Mackinac," guilty of operating a boiler when knowing it to be in a dangerous condition. His license has been ordered revoked. No judgment has been rendered in the case of Captain McVey of the vessel and the Service has not announced what steps, if any, will be taken in regard to the New York Inspector.

Universal Craftsmen Activities

The Universal Craftsmen Council of Engineers, which held its annual meeting at Akron, Ohio, Aug. 4-8, reelected the old officers and in addition elected as Grand Warden, Charles Clark, of 1344 East 85th St., Cleveland, Ohio, and as Grand Guard, J. R. Haas, 4641 Kenmore Ave., Chicago, Ill. The next convention of the society will be held in Milwaukee, Wis. Walter H. Damon, Grand Worthy Chief, is making an extended visit to the subordinate lodges, having left Springfield, Mass., on Aug. 30 and will return home sometime in October. This trip will cover the greater part of the country.

Taschereau Defends Proposed Chute-á-Caron Scheme

Premier Taschereau of Quebec Province, Canada, recently issued an official statement in connection with criticism aimed at the Chute-á-Caron waterpower development. He briefly told how the falls were originally purchased, twenty-five years ago for $2,000, after an engineer had stated that there would never be any possibility of developing power from them. The present owners of Chute-á-Caron rapids were simply asking to be allowed to develop something that already belonged to them, he stated. The premier expressed optimism as to the future of the Saguenay district, as a result of this 800,000-hp. development scheme. It is expected that $75,000,000 will be spent in the immediate vicinity of the Falls, where a world center for aluminum production is planned. At present the intention is to install 8 units of 8,000 hp. each.

World Power Conference Considers Constitution

In submitting to the various countries a draft of a constitution for the permanent organization of the World Power Conference, it is pointed out that the central office is to be nothing more than a clearing house for the interchange of information on all matters relating to the development of power resources. The conference is to be composed of the existing national committees, together with such other national committees as may be formed hereafter. Where no national committee exists, the government or some representative institution may appoint a representative for the country.

The constitution will place no restriction on the type of national committee each country may choose to select, but it is recommended that each member have some first-hand knowledge of scientific, technical, or industrial power problems. The management of the affairs of the conference are to be vested solely in the national committees. Much emphasis is placed on the determination to have no central super organization. The International Executive Committee is to consist of one representative from each national committee.

It is proposed that the president of the conference always be chosen from the country in which a plenary conference is held. For instance, the Earl of Derby is to be president at the next plenary conference in lieu of the fact that the last plenary conference was held in Great Britain. The selection is to be made by the national committee of that country. Each national committee is to designate a vice-president of the conference for such period as it may see fit.

The International Executive Council is to select its own chairman. At its recent meeting in London it selected D. N. Dunlop for that place. Mr. Dunlop was the organizer of the first World Power Conference. The Council also, it is proposed, may appoint as vice-chairman the representative on the Council of the National Committee of the country in which a plenary conference or sectional meeting is held.

It is proposed further that the chairman of the Council be allowed to appoint the necessary staff for carrying forward the work of the conference. The Council will determine the location of the central office, which is to remain in London until otherwise decided. The Council will determine the basis upon which member companies will contribute to the support of the central office.

Muscle Shoals Commission Meets October 1

The President's Muscle Shoals Commission, which was appointed to study the problems connected with the permanent disposition of the power that is being developed at the Shoals, has been called to meet on Oct. 1. It will remain in continuous session until its report is completed.

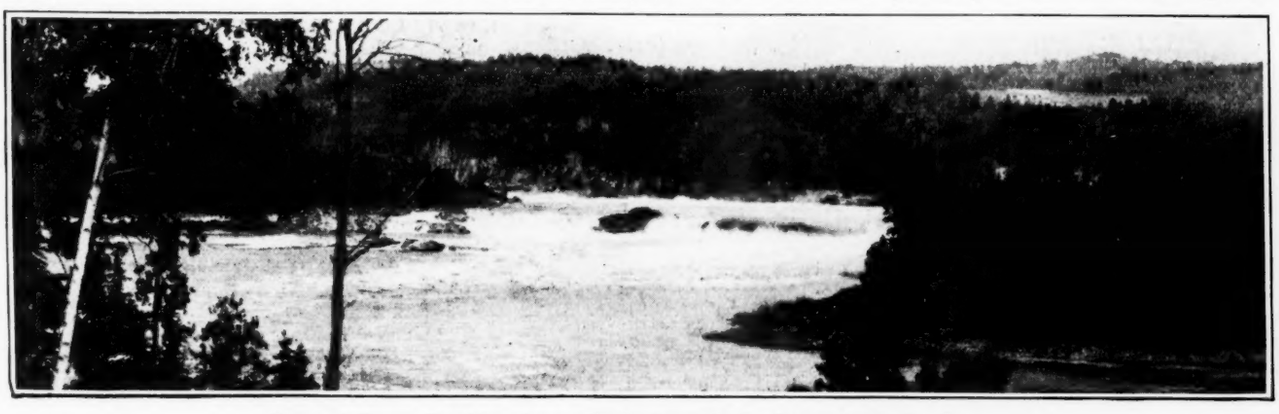
Delaware Elects New Boiler Inspector

Thomas R. Archer, formerly assistant chief boiler inspector of Ohio, has been elected chief boiler inspector of the Delaware Board of Boiler Rules. The Rules and Regulation issued by the Delaware Board are now effective on users, insurance companies and boiler manufacturers. Copies of these rules can be obtained by applying to Mr. Archer, Public Bldg., Wilmington, Delaware.

Soviet Governments Turn to Water Power

According to the press there are two big power projects being carried out by the Russian Soviet Republic—one in the neighborhood of Leningrad and the other in the Ukraine, near Ekaterinoslav, where by utilizing the water of the Rivers Volchov and the Dnieper, two power stations are being constructed. Another project, the most ambitious of all, is in Georgia, it is stated, where the river systems of the Kura and the Angarak are being utilized and a great dam built at Semo Aftchala, near Tiflis. This is expected to have an output of 36,000 hp., and to be opened next year.

The Soviet government of Georgia has appointed a commission to study the problem of the smelting of the ferro-manganese ore produced in the Tchiatury mines, which is now being exported in the crude to Wesphalia, Alsace-Lorraine and England. This commission is now studying the possibilities of the Rion and Skoniska Rivers where, it is reported, it is expected 22 power stations of 200,000 hp. output may be built to furnish power



Chute-á-Caron Rapids where will be located the $75,000,000 development

for the smelting of the ores. Professor Ludins, of the Charlottenburg Technische Hochschule and other German engineers, who have been working on the scheme finished their drawings in April.

The Georgians are at the same time considering the development of electricity by means of the oil from the Baku-Batum pipe lines. This oil would afford the cheapest fuel for power.

Leon Trotsky, as head of the Scientific and Technical Bureau of the Supreme Economic Council, in charge of the electrical development, expressed approval of a vast project for the construction of a hydro-electric power station of 300,000 hp. and 1,200,000,000 kw.-hr. capacity per annum on the River Dnieper in Southern Ukraine.

Trotsky said that American specialists will be invited to investigate the capabilities of the enterprises and that the government will be requested to assign $500,000 for the expenses of this investigation. The whole project would involve an expenditure of $200,000,000.

The proposed power station would be constructed in the midst of the rich manganese and iron ore mines in the districts of Nikopol and Krivoy-Rog on the Lower Dnieper.

Foreign capital will be needed to finance the project, but it is not intended to turn over the entire concession to foreigners.

Developed and Potential Water Power in the United States

The Geological Survey has just given out its up to date figures on the developed and potential water power in the United States, summarized according to sections as follows:

DEVELOPED WATER POWER IN THE UNITED STATES

1925

(Plants of 100 horsepower or more)

Division and State	Total		Public Utility and Municipal		Manufacturing and Miscellaneous	
	Number of Plants	Capacity in Horsepower	Number of Plants	Capacity in Horsepower	Number of Plants	Capacity in Horsepower
United States.....	....	10,037,655	....	8,287,332	....	1,750,323
New England.....	1,230	1,398,803	251	656,270	979	742,533
Middle Atlantic.....	611	1,948,449	402	1,624,316	209	324,133
East North Central..	346	884,760	5	661,445	121	223,315
West North Central	194	514,753	127	414,692	67	100,061
South Atlantic.....	....	1,589,304	....	1,352,478	....	236,826
East South Central..	53	396,791	38	379,683	15	17,108
West South Central	29	31,317	14	27,105	15	4,212
Mountain.....	234	937,078	185	915,737	49	21,341
Pacific.....	299	2,336,400	244	2,255,606	55	80,794

	1924			1921		
	Total	Public Utility and Municipal	Mfg. and Misc.	Total	Public Utility and Municipal	Mfg. and Misc.
United States.....	9,086,958	7,348,197	1,738,761	7,926,958	6,200,380	1,726,578
New England.....	1,387,364	644,831	742,533	1,310,507	583,130	727,377
Middle Atlantic.....	1,731,881	1,408,173	323,708	1,478,904	1,167,539	311,365
East North Central..	829,854	625,826	204,028	738,663	542,889	195,774
West North Central	459,736	376,864	82,872	444,396	360,625	83,771
South Atlantic.....	1,295,978	1,045,728	250,250	1,076,909	799,767	277,142
East South Central..	345,584	323,816	21,768	245,534	228,380	17,154
West South Central	16,727	12,515	4,212	16,274	12,515	3,759
Mountain.....	880,783	860,937	19,846	827,101	806,472	20,629
Pacific.....	2,139,051	2,049,507	89,544	1,788,670	1,699,063	89,607

(a) POTENTIAL WATER-POWER RESOURCES OF THE UNITED STATES

State and Division	Available 90 Per Cent of the Time		Available 50 Per Cent of the Time	
	Horsepower	Per Cent	Horsepower	Per Cent
United States.....	34,818,000	100.00	55,030,000	100.00
New England.....	998,000	2.87	1,978,000	3.60
Middle Atlantic.....	4,317,000	12.40	5,688,000	10.35
East North Central.....	737,000	2.12	1,391,000	2.53
West North Central.....	871,000	2.50	1,844,000	3.35
South Atlantic.....	2,476,000	7.11	4,464,000	8.11
East South Central.....	1,011,000	2.90	2,004,000	3.64
West South Central.....	434,000	1.25	888,000	1.61
Mountain.....	10,736,000	30.83	15,513,000	28.19
Pacific.....	13,238,000	38.02	21,260,000	38.63

National Safety Congress Program

The program of the Fourteenth Annual Safety Congress which is to be held in Cleveland, Ohio, Sept. 28 to Oct. 2, will have papers of interest to *Power* readers as follows: "Hazards of Ice Manufacturing Equipment," by W. H. Towne, manager, Gifford-Wood Co., Chicago, Ill.; "Ice Plant Hazards," by George Steers, Jr., Kalamazoo Ice & Fuel Co., Kalamazoo, Mich.; "Fuel Oil —The Elimination of All Hazards Incident to Its Handling," by John H. Weller, manager, Barber Asphalt Co., Maurer, N. J.; "Safety in Hydro-Electric Plants," by Charles A. Sears, manager, Mississippi River Power Co., Keokuk, Iowa.

New Hydro Projects for Spain Planned

The Spanish government has granted a concession for the construction of important canal works on the Guadalquivir River between Córdoba and Seville. The project includes, besides the canalization of the Guadalquivir, the erection of large hydro-electric plants and the construction of a reservoir of 400 million cubic meters and a dam at Jandula, which will serve to control the falls between Córdoba and Seville. The concession, granted to a Spanish company, is for ninety-nine years, and covers eleven development projects in addition to the Jandula enterprise.

The British Institution of Electrical Engineers has elected the following officers: President R. A. Chattock; vice-presidents, Lieut.-Col. K. Edgcumbe, Prof. W. M. Thornton; treasurer P. D. Tuckett.

Carnegie Tech Outlines Plan of Research

The research program in mining and metallurgy of the Carnegie Institute of Technology, Pittsburgh, Pa., for the coming year contains topics of interest to *Power* readers as follows: "Time-Pressure-Relations in Combustion of the Fine Sizes of Coal-Dust," by C. M. Bouton, associate research chemist and Garnet Phillips, research fellow: "A Study of the Propagation of Flame in Mixtures of Natural Gas and Air," by H. F. Coward, principal assistant, Safety in Mines Research Board, England, G. W. Jones, associate chemical technologist, Bureau of Mines, and Ben E. Hess, research fellow; "A Study of the Mechanism of Corrosion and the Factors Effective in its Control, in Steam Power Plant Operation," by R. E. Hall, physical chemist, Bureau of Mines and E. A. Hertzell, research fellow.

Obituary

Joseph Mayo, pioneer in electrical power development in California, died suddenly in Berkeley, Aug. 4. Mr. Mayo settled in California forty years ago and was identified with electrical projects in Healdsburg, Crockett and Martinez.

William H. Outtrim, head of the stationary motors department of the River Works of the General Electric Co. at Lynn, Mass., died at his home in Swampscott Aug. 17 at the age of sixty-one. He had been employed by the company for more than forty years.

Austin R. Dodge, Consulting Engineer for the General Electric Co., died at Schenectady, N. Y., on Aug. 29. Mr. Dodge was a prominent member of the Power Test Code Individual Committee No. 11 in complete power plants. He was born in Southbridge, Mass., in 1869 and was educated at Worcester, receiving his degree of B.S. in 1893 and his M.E. degree in 1895. In 1896 he began his work with the General Electric Co. and has been connected with that company ever since. He has been in charge of the turbine work and, later, of the experimental turbine department. A new type of steam-flow meter was developed by him during the more recent years.

H. F. Mueller, of Minneapolis, died on Aug. 29 as the result of an automobile accident near Farmington, Minn. In driving up behind a wagonload of hay at night, he failed to notice the binding pole which was projecting a number of feet behind the wagon and it unfortunately caught him on the forehead. The injury proved fatal in a few hours. In 1866 Mr. Mueller was born in Germany, coming to this country in 1893 with an exhibit of a triple-expansion marine-type engines for the World's Fair which was held in Chicago at that time. This engine was purchased by the Washburn-Crosby Co., and Mr. Mueller was engaged as chief engineer. Some time later he became identified with the Allis-Chalmers Manufacturing Co. as erecting engineer and then with the Minneapolis Steel & Machinery Co. in the same

capacity, eventually returning to the Washburn-Crosby Co. with which firm he remained until 1916 when he went into business for himself to market the Mueller boiler compounds. In this he was successful to a remargable degree. Originally, he was a naval engineer, having served his time with the German Navy. He was recognized as an authority on Corliss engines and was a mechanic of exceptional ability. He was an active worker in the N.A.S.E., having been elected as the first president of the Minnesota state association. Also he was a member of the A.S.M.E. and a Mason. He is survived by his widow and a daughter eight years of age.

Personal Mention

J. F. Fraser, of Halifax, Nova Scotia, has been appointed chairman of the Nova Scotia Power Commission to succeed E. H. Armstrong, ex-Premier of the province.

K. C. Schluss for over twenty-two years superintendent of power and equipment with the southwestern district of the Puget Sound Power & Light Co. has resigned to accept an appointment as general superintendent of the Western United Gas & Electric Co. in Illinois.

C. A. Johnson, formerly power plant and substation engineer for the El Paso (Tex.) Electric Co., has been transferred to the Lowell (Mass.), Electric Light Corp., where he will perform similar duties. These properties are both under Stone and Webster management.

Harold Almert has resigned as general manager and secretary of the American Association of Engineers. Miss M. E. McIver will be acting secretary for the present and D. B. Steinman, president of the society, will take care of general administration and the editing of *Professional Engineer.*

A. J. T. Taylor, president of the Combustion Engineering Corp., Ltd., Toronto, is taking a small party of American and Canadian consulting engineers on a trip to Sweden, Holland and Germany to study the application of the Ruths steam accumulator and also the high pressure non-condensing turbines. The party left on the "Majestic" on Sept. 12 and it is expected that they will not return before the end of October.

Trade Catalogs

Valves—The Lunkenheimer Co., Cincinnati, O. "Guide to Better Service," contains pictures of the valves, with sizes and weights, manufactured by the company.

Capacitors—The General Electric Co., Schenectady, N. Y. Bulletin Gea-77, "Capacitors," describes the device for power-factor correction on electric generating and distribution systems and for direct installation at motor terminals on low-voltage circuits. It is well illustrated with charts, diagrams, tables and photographs.

Gages and Water Columns—The Reliance Gauge Column Co., 5902 Carnegie Ave., Cleveland, Ohio. Catalog "N," "Reliance Steam Specialties," contains descriptions of safety water columns, small low-water alarms, signals and wiring details for electric alarms, water gages, seamless floats and other specialties designed for high-pressure boilers manufactured by the company. The catalog is well illustrated and may be obtained from the company upon application.

Valves—Merco Nordstrom Valve Co., 121 Second St., San Francisco, Calif. Catalog "Merco Nordstrom Plug Valves," covers the design, operation and lubrication of these straight, three, and four-way plug valves. It is well illustrated with drawings and contains tables of dimensions, etc.

Lightning Arrester — Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa. Circular No. 1737, "The Autovalve Lightning Arrester," describes with various illustrations this device for the protection of generating and transmission apparatus. This circular supersedes C-1695-A.

Coming Conventions

American Electric Railway Association. James W. Walsh, 8 West 40th St., New York City. Convention and exhibits at Young's Million Dollar Pier, Atlantic City, N. J., Oct. 5-9.

American Electrochemical Society. Dr. Colin G. Fink, Columbia University, New York City. Convention at Signal Mountain Hotel, Chattanooga, Tenn., Sept. 24-26.

American Institute of Electrical Engineers. F. L. Hutchinson, 29 West 39th St., New York City. Pacific Coast convention, Seattle, Wash., Sept. 15-17.

American Society of Civil Engineers. George T. Seabury, 29 West 39th St., New York City. Fall meeting at Montreal, Oct. 14-16.

American Society of Mechanical Engineers—Calvin W. Rice, 29 West 39th St., New York City. Annual meeting at New York City, Nov. 30-Dec. 3.

American Society of Refrigerating Engineers, William H. Ross, 154 Nassau St., New York City. Annual meeting at New York City, Nov. 30-Dec. 3.

American Welding Society. M. M. Kelly, 33 W. 29th St., New York City. Fall meeting and Exposition of Welding Equipment and Accessories at the Massachusetts Institute of Technology, Cambridge, Mass., Oct. 21-23.

Association for the Advancement of Science. Burton E. Livingston, Smithsonian Institution, Washington, D. C. Annual meeting at Kansas City, Dec. 28, 1925, to Jan. 2, 1926.

Association of Edison Illuminating Companies. Preston S. Miller, 80th St. and East End Ave., New York City. Annual meeting at New Arlington Hotel, Hot Springs, Ark., Oct. 19-23.

Association of Iron & Steel Electrical Engineers. John F. Kelly, Empire Bldg., Pittsburgh, Pa. Annual meeting at Philadelphia, Pa., Sept. 14-19.

Chemical Industries. Tenth Exposition at Grand Central Palace, New York City. Sept. 28-Oct. 3.

Eastern Ice Manufacturers Association. W. H. Ross, 35 Warren St., New York City. Convention at Atlantic City, Nov. 23-25.

Electric Power Club, S. N. Clarkson, B. F. Keith Bldg., Cleveland, Ohio. Fall meeting at Briarcliff Manor, N. Y., Oct. 19-22.

Empire State Gas & Electric Association. C. H. B. Chapin, 5618 Grand Central Terminal Bldg., New York City. Meeting at Lake Placid Club, N. Y., Oct. 1 and 2.

Illuminating Engineering Society. Norman D. MacDonald, 29 West 39th St., New York City. Convention at Detroit, Mich., Sept. 14-18.

Iron and Steel Exposition. John F. Kelly, 706 Empire Bldg., Pittsburgh, Pa., Sept. 14-19. Exposition at the Philadelphia Commercial Museum, Philadelphia, Pa., Sept. 14-19.

National Association of Practical Refrigerating Engineers, Edward H. Fox, 5707 West Lake St., Chicago, Ill. Sixteenth annual convention and educational exhibition at Statler Hotel, Detroit, Mich., Dec. 8-12.

National Exposition of Power & Mechanical Engineering. Fred W. Payne, Manager, Grand Central Palace, New York City. Exposition at Grand Central Palace, Nov. 30-Dec. 5.

National Safety Council. G. H. Cameron, 168 North Michigan Ave., Chicago, Ill. Fourteenth Annual Safety Congress at Cleveland, Ohio, Sept. 28-Oct. 2.

Fuel Prices

COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; *mine run* except Pittsburgh gas slack:

Bituminous, Net Tons	Market Quoting	Sept. 5 1925
Pool 1	New York	$2.75@$3.00
Smokeless	Boston	2.55
Clearfield	Boston	1.75@ 2.10
Somerset	Boston	1.85@ 2.20
Kanawha	Columbus	1.55@ 1.80
Hocking	Columbus	1.50@ 1.80
Pittsburgh	Pittsburgh	1.90@ 2.00
Pittsburgh gas slack	Pittsburgh	1.50@ 1.60
Franklin, Ill.	Chicago	2.25@ 2.50
Central, Ill.	Chicago	2.00@ 2.25
Ind. 4th Vein	Chicago	2.25@ 2.50
West Ky.	Louisville	1.25@ 1.50
S. E. Ky.	Louisville	1.50@ 1.75
Big Seam	Birmingham	1.50@ 2.00
Anthracite, Gross Tons		
Buckwheat No. 1.	New York	$2.50@$3.00
Buckwheat No. 1.	Philadelphia	2.50@ 2.75
Birdseye	New York	1.60@ 2.00

FUEL OIL

New York—Sept. 10, light oil, tank-car lots; 28@34 deg. Baumé, 5¼c. per gal., 36@40 deg. 5½c. per gal., f.o.b. Bayonne, N. J.

St. Louis—Sept. 3, tank-car lots, f.o.b. St. Louis; 24@26 deg., $1.75 per bbl.; 26@28 deg., $1.80 per bbl.; 28@30 deg., $1.85 per bbl.; 30@32 deg., $1.90 per bbl.; 32@36 deg., gas oil, 5c. per gal.; 38@40 deg., 5.7c. per gal.

Pittsburgh—Sept. 2, f.o.b. local refinery; 30@34 deg., fuel oil, 5¾c. per gal.; 36@40 deg., fuel oil, 6¼c. per gal.

Dallas—Sept. 5, f.o.b. local refinery, 26@30 deg., $1.63 per bbl.

Philadelphia—Sept. 3, 27@30 deg., $2.15@$2.21 per bbl.; 18@22 deg., $1.848@$1.908; 13@19 deg., $1.575@ $1.635 per bbl.

Boston—Sept. 7, tank-car lots, f.o.b. heavy oil, 12@14 deg. Baumé, 4¼c. per gal.; light oil, 28@32 deg. Baumé, 5½c. per gal.

Cincinnati—Sept. 8, tank-car lots, f.o.b. local refinery, 24@26 deg., Baumé, 5¼c. per gal.; 26@30 deg., 5⅝c. per gal.; 30@32 deg., 5⅝c. per gal.

Chicago—Sept. 1, tank-car lots, f.o.b. Oklahoma, freight to Chicago 92c. per bbl.; 26@28 deg., $1.80 per bbl.; 28@30 32 deg., $1.25.

New Plant Construction

Ala., Tuscaloosa — Pure Process Ice Makers Inc., A. F. Norton, Mgr., plans the construction of a plant 30 ton daily output. $40,000 worth of equipment will be installed.

Ariz., Mesa — City Council will receive bids until Sept. 21 for improvements to power and light plant involving 1,000 kw. frequency changer set, three 40,000 to 66,000 v. transformers, etc.; will also receive bids for improvements to waterworks system including one 20 in. pump sump, electric equipment, 2 pumps 1000 g.p.m. capacity, etc.

Ark, Blytheville—Chicago Mill & Lumber Co., plans the construction of a power plant, saw mill, etc., to replace fire loss. Estimated cost $400,000. A. H. Stier is local superintendent.

Ark., Little Rock—Citizens Ice & Cold Storage Co., plans to remodel and improve present plant and construct a new storage plant and warehouse. Equipment will be required.

Calif., Fresno — D. M. Harnwell, Clk., Fresno County, will receive bids until Sept. 18th for the construction of a boiler house for County Hospital. Estimated cost $35,000.

Calif., Long Beach—Walker & Eisen, 701 Great Republic Life Bldg., Los Angeles, Archts., is receiving bids for the construction of a 12 story hotel including steam heating system and electric elevators on Ocean Ave., here, for F. B. Dunn, Los Angeles. Estimated cost $1,000,000.

Calif., Los Angeles—Hospital of the Good Samaritan, 1243 Wilshire St., is having plans prepared for the construction of a 10 story hospital building including steam heating and vacuum systems, 4 elevators, etc. at Shalto and Witmer Sts. Estimated cost $1,000,000. R. D. Johnson, 608 Union Bank Bldg., is architect.

Conn., New Britain—M. Bailey, Foxon Road, East Haven and A. Molstein, 146 Sherman Ave., New Haven, plan the construction of an office and theatre building on West Main St. Estimated cost $800,000.

D. C., Washington—A. L. Flint, General Purchasing Officer of the Panama Canal, will receive bids until Sept. 21st for boilers, power cable, transformers, etc.

D. C., Washington—U. S. Coast Guard, will receive bids until Sept. 30th for 2 d.c. generators, 1 double armature d.c. motor, 1 generator motor, etc.

Fla., Vero Beach—H. G. Redstone, Clk., will receive bids until Sept. 24 for the construction of a sludge digestion sewerage disposal plant including pumps, etc.

Ga., Rome—The Fruit Co., W. B. Broch, Gen. Mgr., plans extension to cold storage plant. Estimated cost $25,000.

Ill., Chicago — Wabash-Monroe Building Corporation, E. A. Jackson, Pres., 608 South Dearborn St., awarded contract for the construction of a 6 story office and stores building at Wabash Ave. and Monroe St. to George A. Fuller Co., 140 South Dearborn St. Estimated cost $3,000,000.

Ky., Louisville—Louisville Hydro Electric Co., will build a hydro electric plant, initial capacity 108,000 hp. in eight 13,500 hp. units with provision for an ultimate capacity of 135,000 hp. The power house 507 ft. long between Rock Island and the Kentucky shore will be constructed under the supervision of the Bellesby Engineering & Management Corporation, 231 South La Salle St., Chicago, Ill. Estimated cost $7,500,000. The Federal Government plans the construction of a dam across the Ohio river from the Indiana shore to Rock Island. Estimated cost $3,250,000.

Me., Lewiston—Central Maine Power Co., W. S. Wyman, Mgr., Augusta, is having plans prepared for the construction of a dam across the Androscoggin River here, cost to exceed $25,000. F. W. Mason, Waterville, is engineer.

Mass., Roxbury (Boston P. O.)—M. N. Tracy, c/o Kennedy & Olmstead, 80 Boylston St., Boston, Archt., will build a repair service garage and boiler room on Lambert Ave. here, by day labor. Estimated cost $40,000.

Mass., Worcester—F. W. Taylor, 438 Main St., awarded contract for the construction of a 10 story office building at 36 Pleasant St. to E. J. Cross Co., 82 Foster St.

Mich., Detroit—J. J. Barlum, 206 East Grand River Ave., is having plans prepared for the construction of a 20 story hotel including steam heating system at Cadillac Square. Estimated cost $2,500,000. Bonnah & Cahffee, 300 Barlum Bldg., are architects.

Minn., Cambridge—Village, S. R. Bronnicke, Recorder, will receive bids until Sept. 18th for the installation of a pump, motor, water mains, drill well, etc.

Miss., Clinton—City will soon receive bids for an artesian well, pumping equipment, etc. Estimated cost $17,500.

Miss., Meridian—The Kaye-Pepsher Ice Co., has purchased site adjoining plant and plans the construction of a new building at 11th St. and 17th Ave. to double capacity.

Miss., Ocean Springs—City plans an election Oct. 3, to vote $75,000 bonds for waterworks improvements including 100,000 gal. reservoir, mains, one motor pump and one engine pump complete, etc. M. L. Culley, Jackson, is engineer.

Mo., Puxico—Puxico Flour Mills, has been granted a franchise to construct a power plant, waterworks system, install ice plant, and 600 hp. generator. Estimated cost $150,000.

Neb., Superior—L. P. Gregory, Clk., will receive bids until Sept. 18 for one 1,200 g.p.m., three 500 g.p.m. centrifugal pumps directed connected to 3 ph. 220 v. motors, Alt. A. one 14 x 10½ x 12 Duplex packer piston steam pump, Alt. B. one 11 x 12 vertical triplex single acting connected to 50 hp. 3 ph. 220 v. motors, Alt. C. two 500 g.p.m. centrifugal pumps directed connected to 3 ph. 220 v. motors; one 6 x 6 single cylinder single acting air compressor 125 lbs. complete with 3 ph. 229 v. motor and air tank or one 350 cu.ft. air compressor or blower to operate at 15 lbs. pressure, etc. Henningson Engineering Co., National Bldg., Omaha, is engineer.

N. Y., Coney Island—(Brooklyn P. O.)—American Hotel Co., 25 West 45th St., New York, awarded contract for the construction of a 17 story hotel at Boardwalk and 29th St. to Cauldwell-Wingate, 381 4th Ave., New York.

N. Y., New York—Owner c/o Griggs, Baldwin & Baldwin, 27 Pine St. plans the construction of a 15 story office building at Lexington Ave. and 27th St.

N. Y., New York—A. E. Lefcourt, 1351 Broadway, plans the construction of a 20 story office building at 625 6th Ave. Architect and engineer not selected.

N. Y., New York—J. I. Walsh, 73 West 11th St., plans the construction of a 15 story apartment on Waverly Place. Estimated cost $1,200,000. Architect not selected.

N. C., Scotland Neck—City plans improvements to municipal power plant. Estimated cost $25,000.

N. C., Winston-Salem—W. M. Nissen, is having preliminary plans prepared for the construction of a 15 story office building. W. L. Stoddart, 50 East 42nd St., New York, N. Y., is architect.

Okla., Enid—City plans an election soon to vote $215,000 bonds for extensions to waterworks including pumps, motors, mains, etc. F. C. McGruder, is engineer.

Okla., Fort Cobb—City is making surveys for new waterworks and distribution systems including pumps, tanks, etc. Estimated cost $35,000. V. V. Long & Co., Colcord Bldg., Oklahoma City, are engineers.

Okla., Fort Cobb—Fort Cobb Ice Co., is having preliminary plans prepared for the construction of a new 15 ton raw water ice plant electrically operated. Estimated cost $30,000. Engineer not selected.

Okla., Oklahoma City—Mann Bros., Cotton Exchange Bldg., had plans prepared for the construction of a 17 story office building. Estimated cost $600,000. Hawk & Parr, Cotton Exchange Bldg., are architects.

Okla., Red Fork—City will soon receive bids for the construction of a new waterworks system including pumps, motors, tanks, mains, etc. Estimated cost $65,000. Holway Engineering Co., Wright Bldg., Tulsa, is engineer.

Pa., Masontown—Borough Council J. J. Mechem, Pres., Borough Hall, will receive bids until Sept. 21st for construction 400,000 gal. addition to filtration plant and pumping station, 300,000 gal. standpipe, furnishing and installing one 450 g.p.m. motor-driven vertical shaft pump, 55 ft. total head, one 450 g.p.m. motor-driven horizontal shaft pump, 450 ft. total head.

S. C., Greenville—The Piedmont Plush Mills, recently incorporated capital $225,000 plans the construction of a plant including a boiler room, etc. J. E. Sirrine & Co., 309 South Main St., are architects. F. W. Symmes, is president.

Tenn., Chattanooga—Atlantic Ice & Coal Corp., Washington St. Viaduct, Atlanta, Ga., is having plans prepared for the construction of a 10,000 ton cold storage plant here. Estimated cost $150,000. Private plans.

Tenn., Chattanooga — Tennessee Electric Power Co., 540 Market St., plans the construction of a new unit to present Hale Bar steam plant.

Tenn., Memphis—Memphis Power & Light Co. and Memphis Street R.R. Co., 4th St., awarded contract for the construction of a 3 story warehouse and distributing plant at Beale Ave. and Walnut St. to Hanson-Worden Construction Co. Estimated cost $250,000.

Tex., Amherst — City plans new water supply and distribution system including new wells, 3 electrical motors, pumps, 75,000 gal. steel tank, mains, etc. Estimated cost $50,000. B. C. Linn is mayor.

Tex., Beaumont—East Texas Electric Co., c/o J. G. Holtzclaw, Mgr., awarded contract for the construction of a power plant 3,000 kw. unit at Necher River and Mansfield Ferry Road to Stone & Webster, 147 Milk St., Boston, Mass. Estimated cost $3,000,000. T. R. Thornburg, in charge of construction.

Tex., Carlsbad—State Board of Control, Austin, is receiving bids for addition to power plant here. Estimated cost $50,000. Phelps & DeWees, Gunter Bldg., San Antonio, are engineers. Electric driven engine, dynamos, etc., will be purchased.

Tex., Commerce — East Texas Teachers College, c/o Professor Whitley, is receiving bids for the remodeling of present heating plant. Estimated cost $50,000. W. R. Ragsdale, West Lee St., Greenville, is architect.

Tex., New Braufels—Comal Power Co., c/o W. B. Tuttle, Pres., Terrell Road, San Antonio, awarded general contract for the construction of a 30,000 kw. capacity power plant here to U. G. I. Contracting Co., Broad and Arch Sts., Philadelphia, Pa. Estimated cost $3,000,000. Contracts for turbines and boilers have also been awarded.

Tex., San Antonio—Mission Produce Co., c/o Produce Row, plans the construction of a packing plant including refrigeration system, etc. Estimated cost $50,000. Engineer not selected.

Tex., San Antonio—A. Steves, Jr., c/o Steves Sash & Door Co., 602 Monteroy St., is having preliminary plans prepared for the construction of a 12 story apartment at Brackenridge Park and Broadway Ave. Estimated cost $1,500,000. Private plans.

Tex., San Antonio—T. B. Baker & Associates, c/o Gunter Hotel, is having preliminary plans prepared for the construction of a 15 story office building at Jefferson between Houston and Travis Sts., also plans addition to Gunter Hotel. Estimated cost $2,000,000 and $1,500,000 respectively. H. S. Green, Alamo National Bank Bldg., is architect.

Wash., Seattle—Maxim Land & Investment Co., c/o H. Bittman, Securities Bldg., Archt., will soon receive bids for the construction of a 12 story hotel at 5th and Virginia Sts. Estimated cost $500,000.

Wash., Tacoma—C. F. W Lundberg, Provident Bldg., Archt., will soon receive bids for the construction of a 10 story apartment including steam heating system, utilizing oil, at Division St. and Broadway for Bricker Investment Co., Provident Bldg. Estimated cost $750,000.

W. Va., Wheeling — H. L. Kirk, City Manager, will receive bids until Sept. 22 for the construction of a booster pumping station at the National Pike, Elm Grove.

Wis., Kaukauna — Green Bay & Mississippi Canal Co., Insurance Bldg., Appleton, is receiving bids for the construction of a power house here. W. K. Kolb, c/o owner is engineer. Owner is in the market for equipment including turbine.

B. C., Prince Rupert—Canadian National R.R., 230 St. James St., Montreal, Que., is having plans prepared for the construction of a hotel here. Estimated cost $1,000,000. J. Schofield, c/o owner, is architect.